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AUGUST 1981

EMPLOYMENT OF THE ENGINEER SYSTEM IN ARID MOUNTAINOUS AND DESERT AREAS--A CONCEPT PAPER

by

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Lieutenant Colonel(P) Theodore G. Stroup, CE

US ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013

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USAWC MILITARY STUDIES PROGRAM PAPER

EMPLOYMENT OF THE ENGINEER SYSTEM IN ARID MOUNTAINOUS AND DESERT AREAS--A CONCEPT PAPER

A GROUP STUDY PROJECT

by

Lieutenant Colonel(P) Paul G. Cerjan, CE
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PREFACE

This Group Study Project was produced under the sponsorship of the US Army War College, Department of Military Strategy, Planning, and Operations. The genesis for the study came from the Director, Combat Development, US Army Engineer School, Fort Belvoir. After initial idea seeding from the Engineer School, the study objective, scope, research methodology and final configuration was developed by the authors, both of the Class of 1981. This concept paper was written to contribute seed material for potential engineer combat development projects--in the doctrine, equipment, training and force structure areas--and to provide unit commanders and staff officers of both engineer and engineer supported units real time facts, considerations and recommendations for potential near term contingency missions or projects in the terrain spectrum of desert and arid mountainous areas.

In a paper of this nature, it was not possible after research and review of the plethora of facts available to completely synopsize all aspects of engineer functions on the battlefield in these harsh terrain areas. Both authors, based on their own backgrounds and experiences, decided the elements of study content. An effort was made to keep considerations and recommendations realistic and timely--rather than those that would require lengthy development processes and large resource outlays. We have sought to identify and examine basic issues and problems confronting employment of the engineer system in these severe terrain regions.

A paper of this scope has taken both of us to various agencies, offices, armies, countries and individuals for our research and source data. At each step, we were met with encouragement, friendship, professionalism and realism. Our debt to many professionals visited, interviewed and assisted is great. To each of our mentors, fellow comrades-in-arms, friends and family members, we offer a hearty thanks for your support.

TABLE OF CONTL :S

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CHAPTER I

INTRODUCTION

THE DESERT---IT'S DIFFERENT

> We haven't looked at desert operations for the last quarter century---It could be about time. There's much to learn---we have hardly begun.
>
> S.L.A. Marshall
> 1970

Yes, it is different! Since S.L.A. Marshall penned the above words concluding an article for Infantry magazine much has happened to change the focus of the US Army from the jungles of SE Asia and the Fulda gap to another politically and economically vital area of the world. The new focus is on an area of the world that presents stark contrasts of requirements in tactics and logistics that the Army has not experienced since the North African campaign. The stark contrasts caused by the terrain spectrum of sand, dust, grit, mudstones, ridges, wadi, heat and cold causes problems for the trainer, the logistician, the strategist, the tactician, the planner, the commander and the soldier heretofore not experienced by our Army since the 1940's. This concept paper focuses on the engineer, his system and planning for its employment in arid mountainous and desert areas.

The Purpose. The purpose of this study is to provide a concept paper or framework for future combat development requirements for employment of the engineer system in arid mountainous and desert terrain. Assessment will be made of the environmental impact of such terrain on the current engineer system structure, doctrine, equipment and training. This study will outline general employment considerations of the engineer system as it exists now and recommend new concepts and changes that could be applied to the engineer system for such a different terrain environment. Such recommendations will encompass force structure considerations, training, tactical employment and equipment requirements.

The Need. Not since WWII and the North African Campaign of the US Army initiated by Operation Torch has the US Army been confronted with the challenges of potential combat in a desert area as it is today. The drift of world politics and economics fueled by a petroleum cartel, internecine warfare in the Moslem world and Soviet opportunistic expansionism has caused a shift of awareness among the managers of national strategy, planners of military forces and trainers of soldiers from a "focus on Fulda" mentality to a more realistic appraisal of potential conflict scenarios around the world. Needless to say, their focus now encompasses the greater Middle East area of our globe.

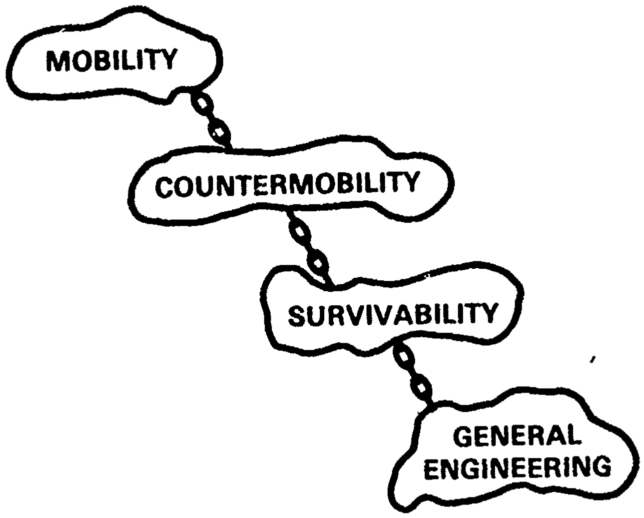
While contingency planning, training, equipping and thinking has intensified in tackling the problems land, sea and air forces would be confronted with in operations in such austere areas, there is a requirement for additional original thought to supplement ongoing actions. One area needing a fresh and/or updated appraisal of doctrine, employment and development is the application and use of the Engineer system in arid mountainous and desert terrain. Our research has found lack of a conclusive and comprehensive analysis and study of such application of engineers in the desert since a schooltext was published by the Engineer School, Fort Belvoir in 1951. Our study serves to initiate the beginning of an effort to focus employment of the Engineer system in such terrain.

The Engineer System. Doctrine establishes engineers as an integral part of the combined arms team. History and battlefield performance verifies this doctrinal premise. A quick review of the system is provided herein as a basis for discussion standardization for this study. The functions of the system and its location as defined by FM 5-100, Engineer Combat Operations place it in the division area. Our study will expand the location to behind the corps boundary for consideration purposes. This is necessary as in such austere environments, engineer functions will be required almost immediately throughout the area of operations because of the immaturity of existing infrastructure.

The Engineer system as described by FM 5-100:

Is composed of division and corps engineers that can be shifted to weight effort at the critical time and place.	**Provides sustaining or general engineering to all division systems.**
Provides a single point of contact for all engineer activities in the division.	**Is a combat power multiplier that reinforces terrain to the advantage of friendly forces.**
Emphasizes forward support to maneuver elements.	**Establishes normal unit relationships with maneuver elements that strengthen the combined arms concept.**

The missions that it provides on the battlefield are four:



Doctrine outlines each above mission requirements in the divisional area as:

MOBILITY

Fill craters and ditches by dozing or hauling fill material.
Demolish and remove road blocks, trees, or rubble.
Make quick bypasses around obstacles.
Clear paths through minefields with mechanical equipment or rocket-propelled line charges.
Span gaps with assault bridging.
Make combat trails through wooded and heavily vegetated areas.

COUNTERMOBILITY

To concentrate forces at critical battlefield locations.
To assist target acquisition and development.
To destroy targets.

SURVIVABILITY

Defilade/protective positions improve the survivability and effectiveness of friendly forces.

GENERAL ENGINEERING

Improve and maintain essential combat and main supply routes.	Develop forward support areas for rearming/refueling.
Prepare field and air defense artillery positions.	Replace assault or blown bridges with tactical bridging.
Repair airfields, build protective positions, and develop minimum essential logistics areas.	Provide water.
	Conduct terrain studies.

Our research has revealed a need for consideration, as mentioned earlier, of engineer system employment in areas behind division and corps boundaries in its combat and combat support role. This study will not address base development requirements, but will touch those immediate needs of a force introduced into an immature or nonsophisticated area of operations that would have to be addressed by the force engineers from the beginning.

Field Manuals 90-3, Desert Operations and 90-7, Mountain Operations provide adequate doctrinal texts for commander and staff planning. The treatment of environmental effects on equipment, personnel, and tactical operations is adequate. However, the overall impact of engineer mobility, countermobility and survivability on the specifics of tactical operations is lacking. The manuals are excellent starting references but should not be relied upon as sole source documents.

Research Methodology. The study and research methodology chosen by the authors is outlined below:

STUDY METHOD

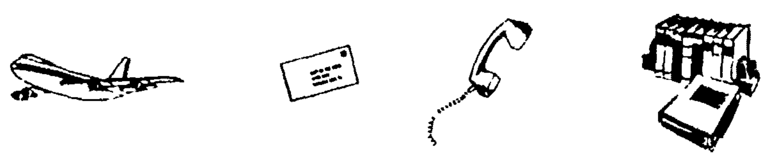
- DEFINITION OF SCOPE
- IDENTIFICATION OF PROBLEMS
- REVIEW OF CURRENT DOCTRINE AND LITERATURE
- TERRAIN ANALYSIS (MID-EAST/SW ASIA)
- HISTORICAL REVIEW
  - WW II (GERMAN/US/BRITISH)
  - KOREA
  - 1967/1973 MIDEAST WARS
- REVIEW OF ON-GOING CONTINGENCY SCENARIOS
- INTERVIEWS
- CONTACT VISITS AND RESEARCH

Initial research revealed a dearth of information in both historical and contemporary sources on employment of engineers in such terrain areas. Consequently the focus of investigative research required a great deal of analysis of historical reports and other documents to decipher the extent of engineer employment in the past; likewise, contemporary documents also reflected a lack of understanding and requisite degree of engineer planning and involvement either in doctrinal or operational matters.

> LESSON LEARNED: There needs to be more documentation for historical and doctrinal purposes of engineer employment. The burden falls upon the engineer family itself to do so.

Our study project allowed us to travel individually and jointly as part of our research effort. This was invaluable for us and contributed greatly in expanding our research perspective, horizons and access to data. The contact visits and outside research sources we utilized were:

CONTACT VISITS/RESEARCH



ISRAEL .... LTC CERJAN
EGYPT .... LTC STROUP
USAES .... FT BELVOIR
CACDA .... FT LEAVENWORTH
USMC .... QUANTICO & 29 PALMS
USARS .... FT KNOX
REDCOM/RDJTF .... MacDILL AFB
ACE .... PENTAGON
OCE .... WASHINGTON
MILITARY HISTORY INSTITUTE .... CARLISLE
20TH BDE/XVIII ABN CORPS .... FT BRAGG
101ST AIRMOBILE DIVISION .... FT CAMPBELL
ENGINEER TOPOGRAPHIC LAB .... FT BELVOIR

Appendix 1 is a sample trip questionnaire taken to Egypt on one of the research visits.

Format Selection. Our research led us to the conclusion that one individual study paper by two Army war college students could not be a panacea for doctrinal, training, equipping and employing deficiencies currently existing for the utilization of the engineer system in arid mountainous and desert terrain. We did not intend for the study to be so initially; rather as stated in the preface, we desired the study to be seed material for potential engineer combat development projects and to provide unit commanders and staff officers of both engineer and engineer supported units facts, considerations and recommendations for potential missions and projects in such a terrain spectrum.

This goal led us to the following format selection:

TERRAIN IMPACT AND CONSIDERATIONS
MOBILITY
COUNTERMOBILITY
SURVIVABILITY
GENERAL ENGINEERING AND SPECIAL ASPECTS
FORCE STRUCTURE CONSIDERATIONS
ADDITIONAL CONSIDERATIONS

The terrain section will focus on generic aspects of arid mountainous and desert terrain, rather than specific countries. The terrain section will not be a terrain analysis of any specific country. It will address what is to be found and what can be expected in the arid terrain of the Mediterranean basin and the horn of the east Africa areas.

The mobility, countermobility, survivability and general engineering sections will cover historical lessons learned (relearned), system employment in such areas and conclude with considerations and recommendations.

The force structure section will delve into considerations our study has led us to from historical experiences and current force needs. This section will lay out questions of mission selection with limited engineer assets and address need for additional (restablished) engineer structure for missions without resources.

The bibliography represents another section that the authors hope will be contributive to our targeted readers. All documents listed are unclassified and in the US Army War College libraries.

An additional section, General Considerations, was added as a chapter to provide information that the authors gathered from their research and study on different aspects of warfare in such a terrain spectrum - that are not necessarily engineer related but could assist the commander and planner.

CHAPTER II

Terrain Aspects and The Engineer System

> You can find it all in the Middle East, if you shop around for it. Desert heat, sand, soaring mountains, rough plateaus, freezing wind, and snow -- even rice paddies along the Caspian's southern shores.[1]
>
> Charles L. Black
> Military Correspondent
> Columbus (Ga) Enquirer

Purpose. The purpose of this section is to create an awareness of the terrain spectrum that would confront the commander, staff planner or troop leader of any Army unit that could be deployed to any arid mountainous and desert area, but in particular, the engineer. As stated in the introduction, orientation is on a generic set of terrain aspects and not country specific aspects.

Terrain and tactical principles of employment on terrain will not be altered in operations in arid terrain. The terrain because of its austerity does take on new importance for consideration as a combat multiplier for the commander. European or continental focus on objectives is changed because of this austerity. Seizure of and retencion of specific terrain may not be required. Orientation on enemy force as always remains paramount in desert operations. Key terrain may be water sources, passes, defiles, crossroads, logistical dumps, airfields rather than those terrain features common to a continental type form of combat. Cover and concealment vary, too, in great contrasts from the flat sand plains to the narrow mountain passes found in the region.

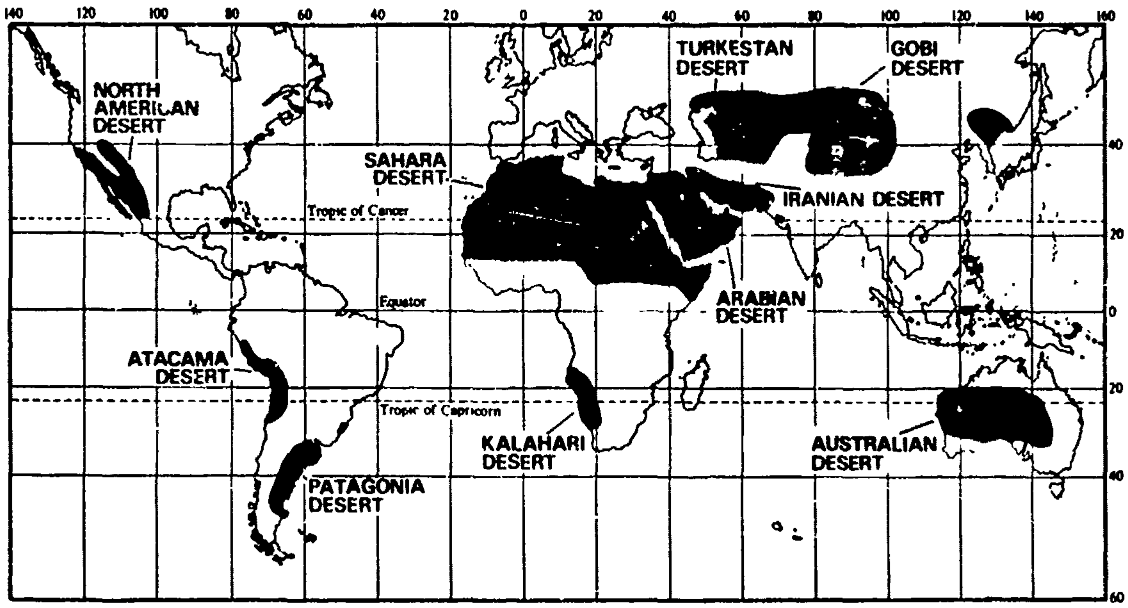
A soldier and his leaders need to know about the desert environment, how to live in it, how to operate in it effectively and how to successfully fight in it.[2] The engineer, being the commander's terrain expert, needs to fully understand, appreciate and utilize the terrain spectrum found in such areas. The engineer must be able to effectively utilize the elements of the terrain spectrum found as a combat multiplier for his unit's mission in conjunction with the engineer system.

Content. This section will address the various elements of the terrain spectrum (environment) found in arid mountainous and desert areas. Specific area focus will be on the geographical area now called the greater Middle East region. Concept of this focus is to remain generic and not country specific as previously mentioned. This area of the globe contains the majority of the world's deserts, although other continental deserts are also found in the Americas, Australia and central Asia. Selection of this area focus stems from its critical position on the world's stage of politics and economics.

This section will address climate and weather, topography, infrastructure, water and other aspects. Engineer specific aspects with respect to this terrain spectrum will be further addressed in subsequent chapters on the functional elements of the engineer system.

THE SPECTRUM: ITS CONTRASTS

The desert area confronts one with stark contrasts. Contrasts of terrain forms, of temperature, of weather types, of vegetation, of wildlife and of habitation. All of these contrasts impact directly on the planner or executor of military operations in this terrain. The impact could be adverse or even fatal, if the soldier or unit is not prepared to understand, to cope and to function in such a potentially hostile environment. Engineer squads could find themselves operating in rocky plateaus or sandy flats with daytime temperatures exceeding the high 90's and nighttime temperatures below freezing. Understanding of this terrain spectrum of contrasts is vital.



Map II-1. Desert Areas of The World.

Aridity. The common factor among all d sert areas is aridity. This coupled with the high temperatures found during sunlight hours accounts for the extreme dryness of the area. Evaporation of water takes place at an extremely rapid rate. At least three fourths of the region under consideration for this study has an average yearly rainfall of less than 10 inches. Humidity can vary though, from zero to almost 100 - depending on wind and location of coastal water bodies.[3] This lack of rainfall in the region can be misleading. The rainfall when it occurs can be a quick, violent deluge causing flash flooding in wadis where there has been no rain in several years. In contrast, some of the desert mountains in this area may get several times the rain as desert lowlands only several miles away.

Climate. The impact of aridity upon the extremes of climatic conditions and the daily weather provides a range of contrasts which definitely impact upon any type of military operations in this region. These sudden dramatic changes vary from extreme diurnal temperature variations, sudden windstorms, high solar glare to intense rainstorms. Appreciation is needed by the military trainer and planner of this noncontinental type weather phenomena.

Temperature. The extreme temperature variation experienced by the *Afrika Korps* upon its introduction into the North African desert provided one of the major initial concerns for its troop leaders. However, discipline, training and acclimatization done properly provided soldiers soon fit to fight even during the greatest heat of the day; if needed.[4]

Extreme temperature ranges can be expected in all types of arid terrain encountered because the solar radiation warming the air and ground to highs during the day can be quickly dissipated in the evening when the clear skies, low humidity and lack of vegetation cover permit a rapid escape of heat from the earth. This temperature range can occur from the arid mountains to the flat coastal sand deserts found in the area under study. For the soldier this diurnal change can often be exacerbated by the constantly blowing wind of some areas of this greater Middle East region, thus, introducing a chill factor that lowers ambient temperature around the body even more with the lack of humidity.

Temperature Variations ^{o}F - Seasonal
(mean daily average)

January	Region	July
47-50°	Atlas Mts. (Morocco, Algeria)	80-84°
52-56°	Sahara (Algeria, Libya, W. Egypt)	80-110°+
69-80°	S. Sahara (Egypt, Sudan)	90-110°+
69-85°	Abyssinian Plateau (Ethiopia, Somaliland)	90-100°
60-75°	Arabian Peninsula	100-110°+
10-45°	S.W. Asia Highlands (Syria, Iraq, Iran)	80-100°+

While the table above illustrates mean daily temperatures for the normal two season year of this arid region, daily temperature variations can range as much as 72°F. The Afrika Korps experienced midday temperatures in the 130-140°F with extreme temperature drops to the low 50's in the evening during the summer in the Sahara. The winter brought similar ranges from 85°F in the day to sometimes 5°F at night.[6] Similar daily contrasts can be taken from variation in the Zargros mountains and the Abyssinian highlands.

Rainfall. Little needs to be said on rainfall in this arid area except a word of caution. As already mentioned in some areas during the winter season, rainfall can occur rapidly and violently in a short period of time turning wadi bottoms into raging currents and some types of soil (clay, silty clay, salt flats) into muddy morasses.

Wind. Another weather factor normally of no concern for those of us experienced with continental climates is the incessant wind found in this arid region. Known by several regional or ethnic names, the desert wind is a force to be reckoned with by all desert occupants. Known as the Sirocco to the Algerian, the Ghibli to the Libyan, the Chili in Tunisia, the Khamsin in Egypt or the Shamal (Seistan) in Iraq (Iran), these winds are seasonal in their intense periods and can bring about dramatic weather-temperature changes, severe reductions in visibility, choking sand and dust and high velocity hurricane force bursts. Having experienced a Khamsin in Egypt on the research part of this study, one of the authors can fully appreciate the area handbook description of a typical Khamsin being a hot driving April wind, gusting up to 40-50 mph, causing a temperature drop of 30°F in two hours and near zero reduction of visibility from sand and choking dust.[7] A force to be aware of, is the seasonal Sirocco or Khamsin, and not to be ignored by any army planner.

Sunlight. Sunlight - daylight, solar radiation, shimmer, atmospheric boil, mirage, solar glare - has an impact on desert operations. Light causes problems for the desert operator by glare, heat reflections, thermal radiation and shimmer (mirages). This is another area for appreciation by the planner and executer of military operations.

Topography.

> Steppe-desert areas embodying open terrain, sandy and stony land surfaces, the lack of water, roads, building materials, landmarks and all other characteristics implied by the term "desert" are no strangers to Soviet military planners.[8]

Desert terrain covers the spectrum of landforms found in any geography book: steppes, valleys, wadis, plains, hills, mountains, plateaus, sand dunes, salt flats and marshes. The topography of the greater Middle East covers it all - although with perhaps regional or ethnic names - jebels, barkhans, subkhats and ergs. Our research has indicated a lack of consensus on type classifying of the different terrain forms found. Our selection is based on our judgement of the most convenient selections f[illegible] terrain planner and user - the engineer and his supported tactical c[illegible]ager.

A great deal can be written about different types of terrain forms in arid regions. Characterization can be made of barreness and severity of the terrain. Steepness can be a characteristic caused by volcanic activity or erosion. Ancient alluvial fans without vegetation can be found. Wind sculpted formations of weathered exposed rock are there, too. Steppes or plateaus, deep terrestrial gashes, dry wadis all exist. Deserts of this region are not just sand dunes and plains, but represent a melange of topography. Our selection of classification places the greater Middle East desert into four major types: the dune/sand desert, the rocky/gravelly plain desert, the rugged hills and mountains desert or the highland desert and the salt flat and marsh desert.

Fig. II-1. Typical sand dune - wind shaped erg. Saudi Arabia.

The dune or sand desert. This area is the most common conception of desert terrain. Found in the Sahara, the empty quarter or Rub'al Khali of Saudi Arabia, the Syrian desert, the Sinai, it represents the majority of terrain found there. But, it historically represents the area least fought over, least inhabitable and least suitable for any type of warfare. It can be characterized by sand, dunes, hard level plains, depressions, no distinct landmarks and scant water resources. It is not necessarily all sand. The sand is the most predominant characteristic of the area. These sandy areas comprise some 20 to 40 percent of desert regions in the world.[9] The sand areas generally provide a range of size in sand particles and dust that will provide maintenance problems for weapons and other mechanical equipment. The dunes, wind blown and shaped, found within the region may be crescent shaped (barkhans) or chains of continuous ridge dunes (ergs) stretching longitudinally. These dunes may vary in height from 6 to over 300 feet. Length on the interior dunes (ergs) could stretch for several miles.[10]

For military operations, such desert areas offer little concealment from air observation, some cover from ground flat trajectory fire, poor trafficability in soft sand, unfavorable terrain for unconventional forces and unstable conditions for tunneling or dug in bunkers. The Afrika Korps found such dunes impeded off road traffic seriously; required constant road maintenance where roads crossed dune areas; and generally provided an impenetrable barrier to friend and foe alike.[11] Study of the North African campaigns finds manuever limited to about sixty kilometer band due to these dune foundations and lack of water.

Fig II-2. Typical rocky/gravelly desert plain. Jordan

The rocky/gravelly plain desert. This landform shares with the highland desert approximately 35 to 50 percent of desert regions.[12] This type of plain in the desert affords the best cross country trafficability for a mechanized force. It affords excellent road and airfield construction compatability. Observation from the air is limited. Concealment from the ground varies with the variance of relief locally, as well as cover from flat trajectory weapons. Long fields of fire are generally the norm for such areas. Depending upon the hardness of the substratum, this type of desert affords good opportunity for bunker construction and entrenchments. Dispersion off road is relatively easy with the good trafficability. Such areas can be interspersed with wadis, lava bolder fields and inhabited infrastructure elements - secondary roads, villages, oases.

Fig II-3. Typical highland desert area. Iran.

The highland desert. Unsuitable for conventional forces, it is arid, has temperature extremes and possesses poor and constricted road nets. Steep side valleys, dissected terrain, exposed bedrock and stony soil, sharp curves, steep gradients, no off road dispersal opportunities, all contribute to make the highland desert area generally favorable for unconventional force operations. Bunker construction is difficult, tunneling is better but hard. Observation is excellent; concealment varies. Deep gaps of varying lengths need to be bridged over. Snow problems and freezing temperatures can occur. Road icing occurs sometimes. Typical conditions cited above can be confronted in the Atlas, Zargros, Elburz mountains and in the Ethiopian highlands.

Fig. II-4. Typical saltflat or subkhat desert area. Sinai.

The salt flat or subkhat desert. A unique terrain feature that is generally impassable for trafficability purposes. Flat in relief, generally sea level in elevation, found close to the coast but may also be found far inland, the subkhat should be considered a natural obstacle. It is an area normally covered with a thin salt crust underlain in most places by a brine saturated soil. Dry during the summer; marshy during the winter, it can be characterized as a desert tundra in reverse. Some wheeled vehicle traffic can during dry season pass over portions, usually only once, before break through on the crust occurs. Recovery is difficult from the lack of firm anchorages or bottom for retrieval.[13] The Afrika Korps characterized the subkhat as salt marshes and labeled them as extremely difficult terrain.

Such marshes played a vital role of natural obstacles in their defense of the Marsa el Brega line. They claimed that fords through at least the North African subkhats exist and could be crossed without difficulty by vehicles.[14] Consideration should be taken of the subkhats potential for offense and defense in planning operations.

Life in the Desert. As expected vegetation in desert areas is scarce. Generally, it can be significant in initial location of subsurface or ground water sources. Such vegetation when found will be scruffy and can hardly be counted upon for cover, concealment or shade.

Animal life, likewise, is sparse and hardy. Reptiles and insects can be expected to be hostile to the human. Pests expected to be found in desert areas are: mites, flies, fleas, ticks, scorpions, lice, parasitic worms and centipedes. All are known to cause great discomfort and pain upon man. Mites, gnats and sand fleas were particularly noxious to troops of north African campaigns in WWII.

Infrastructure in the Desert. Outside of built up metropolitan areas, areas around water supply sources and industrial sites connected with natural resource procurement, man-made structures in the desert are far and few between. Roads and trails are generally scarce in the open desert - bituminous or graveled tracks, narrow widths (10-16 ft), straight alignments, low load capacity (16-20 t), and no maintenance. Roads in the mountainous areas are similar in their simplicity/primitivity of construction and traffic bearing capacity - sharp gradients (10-20%), no off road dispersal area, multiple switchbacks, narrow-low load bridges (10-16 t), steep sides and shoulders, ice and snow problems in some areas, deep chasms to be spanned, poor maintenance of wearing surface and thin bituminous or graveled roadways.

Airfields, outside of major built up areas, generally require STOL or rugged landing carriage aircraft. Ports found in the area vary in capacity, quay or beach capacity, lighterage availability and loading/off loading capability. Power and utility development ranges from scanty and antiquated to modern and efficient. The greater Middle East is undergoing an infrastructure renaissance and infrastructure currency and capability should be high on any engineer's EEI in planning operations. Current library research conducted revealed a lack of information for an up-to-date assessment. The engineer planner should anticipate operations in an underdeveloped region that is modernizing at respectable rates in some areas and lethargically in other areas.

Water in the Desert. The most critical item in warfare conducted in arid regions is water. So critical that water sources become items of tactical and strategic value for opposing forces. What few natural sources that exist may be too brackish or saline for human consumption. LTG Fritz Bayerlein, Afrika Korps, in discussing operations against the British in 1941-42 cited that in all the operations conducted by opposing forces that "...the lack of water in the regions involved was by far the greatest deterrent."[15] General Bayerlein further discusses the problem of water supply in comparing the logistical requirements for the transport of food (1 Kg) and water (4 Liters = 4 Kg) per man on a daily basis.[16] Water supply, location, discipline and control will be discussed in the General Engineering section of this study.

Dust. This element caused the Afrika Korps an untold amount of headaches - tactically, hygienically and logistically. The Egyptian and Israeli armed forces face this fine, infiltrating, granual, grindury, choking demon daily and cite it as one of their major environmental problems from '67, '73 and today.

The comments below from the German Desert Warfare are an excellent portrayal of problems caused by dust.[17]

DUST

a. Effect on Troops, Weapons and Equipment

Men in the desert are constantly exposed to the effect of dust. This bothers the fighting man all the more because he has to endure it in conjunction with heat and the lack of water. There is no universal remedy against dust in the desert. Dust is a betrayer, which enables one to perceive every movement for great distances, even by individual vehicles, both from the ground and the air.

Every footstep on the surface of the desert throws up dust and sand; moreover the almost perpetual winds carry along dust with them, generally in the form of dust columns as high as a house, which form themselves into whirlwinds and wind-spouts. In the beginning the German troops in the desert suffered considerably from dust and had to fight against mental depression. However, they quickly became accustomed to it, so that their fighting power was not affected to any appreciable extent. The dust there does not cause any injury to health, since it does not contain any angular or sharp-edged particles which might lead to lung diseases. The eye inflammations caused by dust did not have any serious consequences. It proved helpful to wear dust goggles, especially in the large clouds of dust produced by moving columns of motor vehicles. Therefore, every soldier in the desert was equipped with a pair of dust goggles.

The effect of dust on weapons and equipment, including motor vehicles, is considerable in the desert. Dust had the greatest effect on motor vehicles, because the dusty air which was sucked into the cylinders attacked the cylinders and pistons and caused these parts to wear out quickly. Special air filters reduced the wear, but could not prevent it altogether. In general purpose cars (Volkswagen) the air intake openings were installed in the interior of the car in order to give the engine purer air In tanks the air was sucked out of the battle compartment. In spite of this, the average lifetime of a Volkswagen engine in the desert was only 12-14,000 kilometers in comparison with 50-70,000 kilometers in other theaters of war. In the desert it was necessary to change tank engines after about 3500 kilometers, while they would last for 7-8000 kilometers in Europe. To be sure, this was due not only to the effect of dust but also to a considerable degree to the necessity of driving long distances across country in low gears. The other parts of motor vehicles (such as the brakes, chassis, and all parts which could be penetrated by dust) also suffered considerably more wear and tear than under normal conditions. It is not possible to give any figures on this point. What is certain is that motor vehicles in the desert need substantially more lubrication than in other theaters of war. No special greases and lubricants were used.

The barrels of guns, as well as all unprotected moving parts, were especially affected by dust. The wear on barrels, therefore, was considerably higher than in a European theater of war. Machine guns, submachine guns and other small arms were the weapons most endangered, because inasmuch as they were used on the surface of the ground they were especially exposed to the effects of dust. It was, therefore, necessary to protect all the movable parts of guns and equipment, especially the breechblocks, by such expedients as wrapping them up when not in use, covering them with shelter halves or by other means. The barrels of artillery pieces and rifles had to be provided with muzzle protectors whenever they were not being fired. In view of the effects of dust, special importance was attached to the care of weapons and equipment, as well as to cleaning them frequently.

b. Effect on Combat Operations

The generation of dust made it practically impossible to conceal marching columns. Dust clouds could be seen even at great distances and enabled one to recognize the size of the columns and sometimes even the type of vehicles (wheeled or track-laying). On the other hand, the effect of dust was also taken advantage of for purposes of camouflage and deception. Dust was often created artifically in the desert chiefly for purposes of deception. Rommel was the first to recognize the possibilities of this method, and he employed it up to the summer of 1942. However, even he often fell a victim to enemy deception measures.

We shall quote the following passage from the diary of Field Marshall Rommel concerning the importance and effect of dust:

"On 13 March 1941 I transferred my headquarters to Sirte so that I could be closer to the front. In order to save time I attempted to reach this area by airplane. In the area of Tauroga a sandstorm came up. The pilot of the airplane turned around, although I tried to get him to fly on. The trip was then continued by car. We were now forced to admit that we had had really no idea of the tremendous force of such a sandstorm. Huge clouds of a reddish hue obscured our vision and the car crawled slowly along the coastal road. Often the wind was so strong that one could not drive at all. Sand dripped down the car windows like water. It was only with difficulty that we could breathe through a handkerchief held in front of the face and perspiration poured from our bodies in the unendurable heat. That was the ghibli. In the silence I made apologies to the pilot of my airplane. One Luftwaffe officer actually crashed with his airplane in the sandstorm that day.

"On 4 April 1941 I got underway with my combat staff at 0300 in order to bring the artillery battalions into their positions before daybreak. In the complete darkenss we did not find the columns. On the next morning we repeated our attempt and were finally able to locate the artillery. Among other things, we ran into the rear of a British outpost area without knowing it. Although we only had three vehicles, of which only one was fitted with a machine gun, we drove up to the enemy at high speed while raising a great deal of dust. This apparently made the Englishmen nervous and they evacuated their position in great haste, leaving weapons and material behind."

c. Effect on Tactical Measures

During the first attack on Tobruk dust had the following effects, concerning which we quote the following passage from Marshall Rommel's diary:

"The "Brescia" and "Trento" Divisions were supposed to attack Tobruk from the west and to raise a great deal of dust in the process in order to deceive and pin down the enemy. During this time the main attack group was supposed to swing around south of Tobruk in a wide arc through the desert and attack from the southeast. The dust which was thrown up deceived the enemy so thoroughly that he guessed that the attack would come from the west and paid no attention to the enveloping movement. When the enveloping group had reached its jump-off positions, their columns were struck by heavy British artillery fire. However, the air was soon full of heat vibrations and gusts of sand blew into the faces of the enemy. Good visibility soon vanished completely.

"On 11 April the encirclement of the fortress of Tobruk was completed. The "Brescia" Division opened the attack. A great deal of sand was blowing and the British artillery could therefore not be expected to direct any aimed fire.

"At about 1300 several enemy tanks moved past Ras el Madauer toward our lines. Because of the tremendous amount of dust, which moreover was being blown toward our positions, it could not be seen whether they were followed by any additional tanks and whether it was really a major attack. Therefore, I immediately committed all the antitank guns which were available in this area. It actually was a major attack and we succeeded in knocking out several tanks and halting the enemy advance.

"Around 1800 on 30 April a new attack was opened against Ras el Madauer. Numerous Stukas cooperated with us. Soon the hill was hidden in thick clouds of smoke and dust. The visibility of the enemy was reduced to zero. It was impossible for them to deliver any aimed fire. Our attack led to a complete victory."

During the advance of the German Africa Corps from the Alamein position into the British rear area the effects of sand varied:

After the Africa Corps had replenished its supply of motor fuel and ammunition in the morning of 1 September, it began to move about 1300. At first the attack made good progress in the violent sandstorm, which blew into the faces of the enemy. Unfortunately, the Italian divisions were very far off and were unable to take advantage of the camouflage provided by the dust clouds in their advance. The vehicles and tanks toiled laboriously through the deep sand drifts which covered the attack area. A fitful sandstorm raged all day and prevented the British air force from attacking in strong formations. When the sandstorm abated during the evening, the spearheads of our attack were engaged in stubborn combat with a strongly fortified enemy defense position and the attack came to a halt. Incidentally reference might also be made here to the statements given in Chapter II, Section 7.

The intervals which the advancing units were ordered to keep from each other in order to avoid dust varied according to whether the dust cloud was being blown in the direction of the advance or to the side. Moreover, since the desert expanses were in general easily traversed by all kinds of motor vehicles, it was possible to drive with gaps between the separate vehicles, thus reducing the effect of dust on the driver and his visibility. In general we used intervals of fifty meters, both in depth and width. During the night this interval had to be shortened for the sake of visibility in order to maintain contact with the man in front.

The generation of dust through the recoil of the powder gases in artillery firing, therefore, was of no special importance for the detection of artillery positions, because the combat zone was always enveloped in dust clouds anyhow. The discharges of guns of especially flat trajectory with a low barrel elevation -- antitank guns -- could be observed and recognized with particular ease by the enemy because of their characteristic dust clouds. Naturally, they also prevented the gun crews from observing the effects of their own fire.

d. Effect on Aircraft and Their Crew

Sand and dust had no appreciable immediate effect on airplanes and their engines, since sand filters were attached to the intake valves. Dust had no effect on the efficiency of the engine, but nevertheless one had to expect more rapid wear and tear on the engine, because very fine dust particles were not entirely kept out by the air filter. Even the special precautions taken during refueling did not always provide hundred percent security.

Very heavy sandstorms made flights practically impossible because of the extremely poor visibility when taking off. However, they were comparatively rare. The ghibli brought sand out of the interior at heights of as much as 5000 meters; it was still easily visible 100 kilometers out to sea, and indeed occasionally was even carried as far as the European continent. This greatly hampered horizontal visibility, especially against the sun. Sometimes visibility was reduced to below ten meters. On the other hand, vertical visibility was only slightly impeded. It was only in exceptional cases that direct observation and aerial photography furnished satisfactory results about target details. In all airfields which consisted merely of sand it was difficult, and sometimes dangerous, for several airplanes to take off and land together. When there was no wind the dust remained hanging over the ground for an endlessly long time, so that in spite of extensive improvisations, formation take-offs failed in their purpose. Landings had even more unfavorable effects, since machines with empty fuel tanks simply had to land, in case they could not reach an alternate airport. When the wind was blowing, airplanes took off with a slight cross wind, so that the dust raised by the take-off would be blown to one side and not disturb the pilot behind. Difficulties also arose in dropping bombs on point targets, since the dust thrown up by the first bomb made it impossible to sight the target accurately. Although the breathing, sight and other functions of the men in the machine were hardly disturbed by sand, the radio equipment was more sensitive. Many radio failures could be traced to this cause. The mose widely different methods were adopted to reduce the ill effects of dust in the airfields.

(1) By selecting surfaces that were somewhat grassy or crusty even if they possessed other disadvantages.
(2) By laying out abnormally large airfields or several airfields located close together.
(3) By reinforcing the surface of airfields with asphalt or mats.

Nevertheless, dust and sand also had certain advantages for observers and scouts. They made it easier for the latter to detect every movement, even on trails and airfields. However, inexperienced crews often overestimated the strength of the enemy.

The tracks visible in the desert sand also enabled one to recognize where enemy troops had passed, as well as the strength and objective of the movement.

Besides the sand filters attached to the intake valves no protective devices were installed either in the engine or in the airplane itself. On the ground it was possible to protect airplanes, engines and machine parts against sand only to a limited extent by the use of awnings. Repairs were made in repair tents.

CHAPTER II

FOOTNOTES

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3. J. Trenton Kostbade, et. al., Regional Geography of the World, p. 344.

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7. US Department of the Army, DA Pam 550-43, Egypt: Area Handbook, p. 64.

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10. Chaim Cohen, LTC, "Military Engineering in the Sinai Desert." The Military Engineer, November-December, 1973, p. 379.

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15. Fritz Bayerlein, LTG, Supplement - German Experiences in Desert Warfare During World War II, p. 50.

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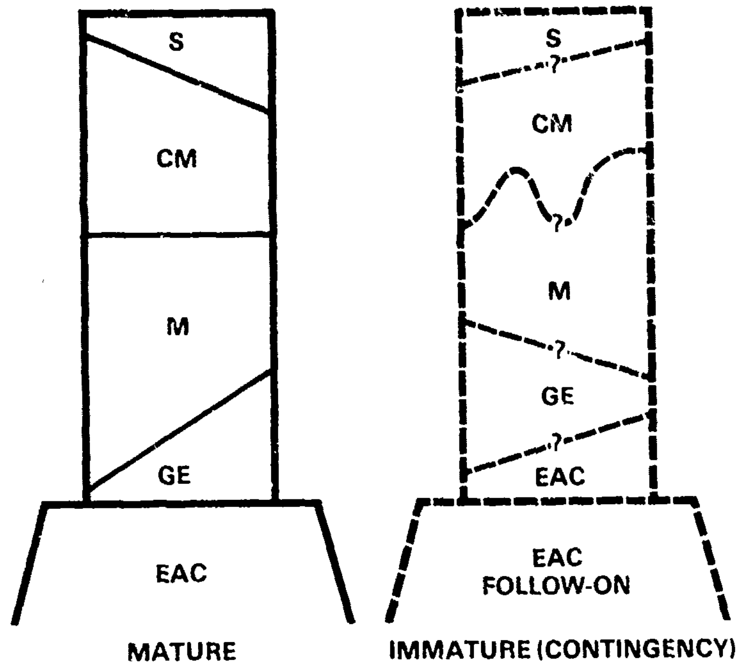
17. Ibid., pp. 56-60.

CHAPTER III

MOBILITY

INTRODUCTION

Before discussing the employment of specific engineer systems in mountain/desert operations, it would be beneficial to draw a comparison between the allocation of engineers to systems in a mature theater (NATO) versus an immature theater or contingency area of operations. Figure III-1 represents a schematic distribution of engineer systems effort in a corps for both scenarios. In the mature theater, the proportionment of engineers by system is defined and supported by well developed requirements. Echelons above corps (EAC) requirements do not impact on the corps engineer force structure in a NATO type scenario. The contingency theater, not being developed in infrastructure, may require satisfaction of EAC engineer functions immediately by the force engineer element. These EAC requirements place an additional demand on the corps engineer force structure. The ideal mix of engineer forces allocated to the different subsystems necessitates careful evaluation by the engineer planner in accord with the command guidance. The following discussions will put forth considerations for assisting the maneuver commander's decision process in the allocation of engineer forces to each of the subsystems.



SCHEMATIC COMPARISON OF CORPS ENGINEER SYSTEMS EFFORT IN MATURE VS IMMATURE THEATERS.

M – MOBILITY S – SURVIVABILITY
CM – COUNTERMOBILITY GE – GENERAL ENGINEERING
EAC – ECHELONS ABOVE CORPS

Figure III-1

Historical research provides a wealth of lessons learned; however, there is no substitute for the levels of experience gained through actual or similar mission area training. Because we have not developed an experience base in large scale (corps) operations in arid desert/mountainous terrain in the last thirty-five years, the commander and planner face a difficult force allocation process for a greater middle east contingency. For such scenarios, defensive operations are the primary orientation of the force in the initial phases of deployment. Defensive operations would continue through the early stages of logistics base expansion and force build-up.[1] This defensive phase would be marked by operations to delay, destroy or expel the enemy to allow future transition to offensive operations.[2]

The difficulty of the force allocation process is the result of the impact of a number of significant elements:

- The threat can span the spectrum from guerrilla activity to organized forces with modern weapons, Soviet or Soviet supported. Consequently, the allocation process must remain flexible to allow tailoring to the threat.

- Host nation support, level of infrastructure and potential for third country basing impact heavily on the allocation process.

- Air/Sealift constraints, particularly in the early stages of deployment limit the quantity of engineer forces and engineer equipment.

- The sheer magnitude of the potential operational area dictate mobility considerations, and the unit selection/configuration.

- Much of the required force structure will consist of reserve components; mobilization time is critical to time - phased deployment.

These elements must be considered in context with one overriding consideration - a contingency operation in the middle east is <u>different</u>. . different in environment, and different in the training/readiness aspects the US Army has focused on in the recent past. The difference can be illustrated by the following factors:

- The extensive distances over which tactical operations will take place governs the type forces best suited for deployment. These are initially airborne, airmobile and light infantry units, with the follow-on potential for mechanized/armor forces.

- Support of these forces may require the use of the Temporary Forward Operating Base (TFOB) concept, in addition to providing a secure lodgement area and/or a third country operating base - all marked by extensive, lengthy LOC's.

- Traditional force allocation rules, such as those utilized for NATO type corps, may be invalid. As mentioned, EAC needs must be included.

- Environmental considerations demand special training programs oriented to the mission area.[3]

It is within this framework that we discuss the Engineer System in the greater Middle East contingency environment.

GENERAL

The engineer mobility system is composed of those tasks performed by engineers which assault the terrain in order to move the force. The system is normally executed forward of the brigade rear boundaries by divisional engineers, corps engineers, or a combination of both. Tasks range from clearing lanes through minefields, constructing combat trails and destroying anti-tank ditches and obstacles to assisting maneuverability of the force as required.

Key to the allocation of engineer effort to the mobility role is the mission of the force. The mission will dictate the placement of engineers within the battlefield. Offensively, engineers would be well forward, while defensively, they would generally be displaced in depth.

In a Middle East environment, the mobility tasks of the engineers in the forward areas are reduced. The reliance on helicopters for movement, and the lack of motorized elements in the forward areas, suggests that the engineer mobility role may be more heavily weighted to supporting offensive operations than any other tactical operation. Minimal local ground mobility requirements may be necessary to support TFOB operations. Other divisional area and corps rear mobility requirements would be accomplished by corps general engineering assets.

Extensive, lengthy LOC's in the early stages of operations will, for all practical purposes, be unsupportable. As the dependence on ground transport in the forward areas increases, so does engineer allocation to the mobility role, particularly as the contingency corps transitions from the defense to the offense.

Existing ground lines of communication in the desert are scarce, with few roads or tracks. Mountain roads are equally poor, follow defiles and contour lines, and marked by many hairpin turns.[4] Cross country mobility, while obtainable in the desert with difficulty in some areas (Figures III-2, III-3), may be an almost total impossibility in the mountains (Figure III-4).

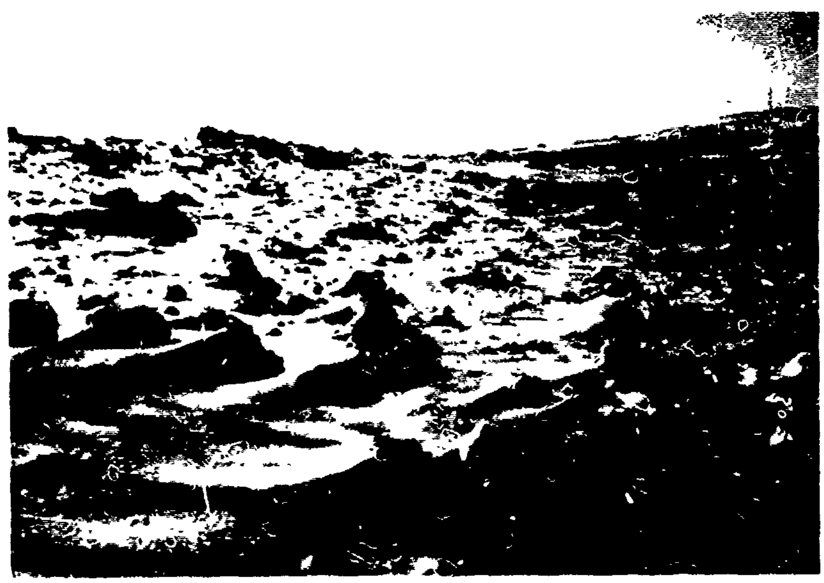


Figure III-2

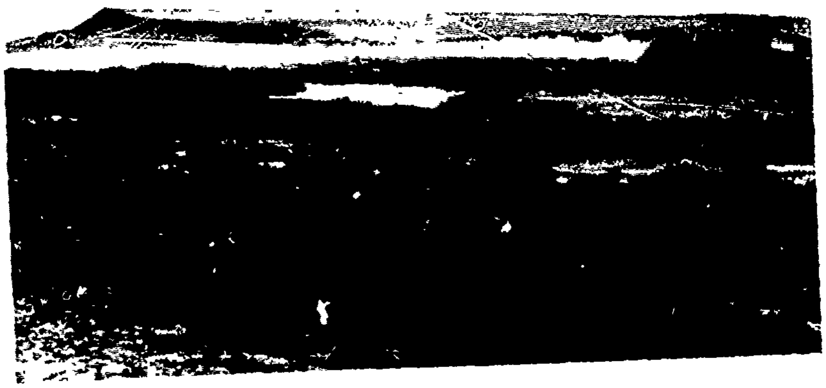


Figure III-3

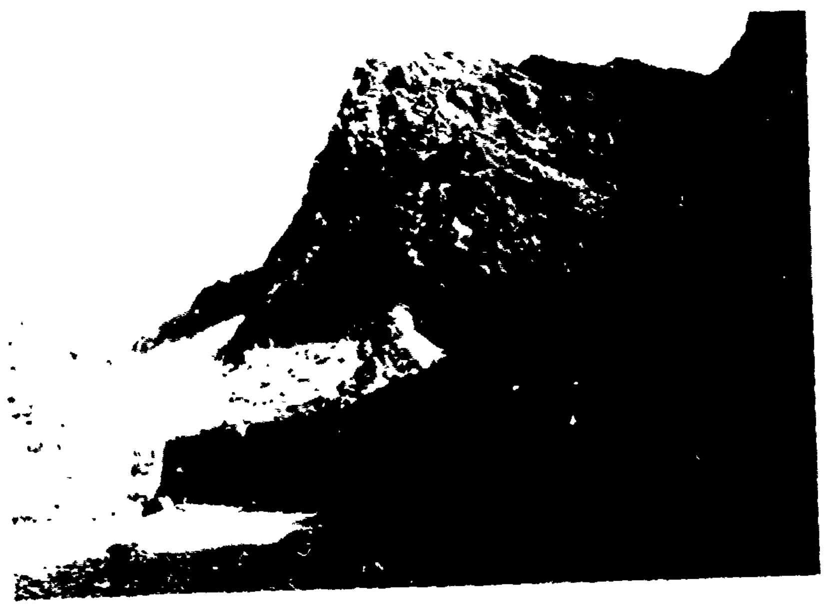


Figure III-4

LESSONS LEARNED

Historical research, primarily from WWII and the most recent Arab-Israeli conflicts, has produced lessons learned of considerations for and employment of engineers in the mid-east environment. Although the forces studied were heavily mechanized, the lessons are equally valuable to a light airborne or airmobile force. The potential for Soviet involvement, which would be heavily mechanized, gives further validity to the historical problems, techniques and tactics which have been identified. Soviet desert/steppe operations in the Trans-Baikal, 1941-45, provide data also, and are the basis for Soviet desert training programs today. The lessons learned for mobility were:

- Troops which are not motorized (mobile) are valueless in desert warfare and are ineffective against a motorized enemy.[5]
- Engineers must be placed as far forward as possible in the initial assault to quickly breech/overcome obstacles.[6]
- Standard mine clearing drills were established by most units.[7]
- In desert warfare, retrograde movements will usually be restricted to roads and will be difficult owing to the lack of natural obstacles favoring new defense lines.[8]
- Use of booby traps was devastating to morale and the rapid movement of forces.[9]
- The most effective obstacle to mobility was the sporadic mining of long stretches of road.[10]
- Salt flats provide natural obstacles to mobility; WWII techniques were to close gaps with mines.[11]

• Sporadic mining of roads in defiles proved to be the major deterrent to Israeli mobility in the 1978 Letani Operation.[12]

• Every possible source must be utilized to gain information on enemy mine operations; experience indicates:

Air Photos	-	Limited
Prisoners	-	Very Limited
Listening (at night)	-	Not Useful
Night Patrol Reports	-	Very Limited
Daylight Reconnaissance	-	Best method; accomplished mostly by engineer officers.[13]

• Long range patrols provide invaluable reconnaissance behind enemy lines.[14]

• The need for expanded reconnaissance capability, particularly engineers, is significant.[15]

• Engineer reconnaissance must be with the most advanced tactical reconnaissance; priority across the entire front; specific attention to obstacles to movement, water sources, engineer supplies and terrain.[16]

• Engineers . . . development (location) of water sources may be possibly the most important role. Reconnaissance for water requires considerable emphasis.[17]

• Engineer units accomplished more work at night than in daylight; night training is most essential for every type engineer mission.[18]

• Training preparation for operations in desert environment must emphasize navigation; orientation by compass/stars, driving by march compass, night marching and movement attendant to operations in open terrain.[19]

• Aerial photographs yielded much useful information, but only physical reconnaissance could establish required information for countermine operations.[20]

• Astronomical observation teams provide a significant capability for navigation.[21]

• Russian experience in the Far East indicated a requirement for 2-3 times more engineering troops and equipment in a desert environment.[22]

• Soviet engineers (Israeli also) construct rough tracks parallel to roads whenever possible . . . most rapid, successful method of opening interdicted routes.[23]

• Israeli experience in the Sinai delineated engineer mobility tasks as:

.. In Dunes

- Reduce marginal slopes
- Clear lanes in minefields

.. In Mountains

- Destroy anti-tank ditches and obstacles
- Smooth rock steps
- Prepare short paths into and out of canyons
- Reduce slopes along short distances
- Clear lanes in minefields[24]

Employing the System

In discussing the employment of the engineer mobility subsystem, the Temporary Forward Operating Base (TFOB) concept will be used as an operational focal point since it reflects current contingency corps doctrine.

The primary LOC facility within a TFOB would normally be an existing airfield - fixed or tactical. The requirement for construction of a C-130 tactical field may be necessary. Current divisional airmobile/airborne equipment TOE's are capable of constructing/repairing tactical airfields, although much equipment in the inventory has exceeded its useful life. Programed purchases of light equipment for airborne/airmobile use in the near term (FY82-83) should eliminate current equipment shortcomings. The repair of damaged fixed facilities would exceed divisional capability, requiring corps combat engineer battalion or support equipment be committed in support of a TFOB on a mission basis. Minimal road network support within a TFOB would also be required for repair of enemy road interdiction, and to establish and improve combat routes between elements as necessary. Such demands would be much more difficult to satisfy in mountainous terrain. Given mission plans to support a network of TFOB's and divisional battalion support of mobility/countermobility operations, the available divisional assets will more than likely exceed organic capability. Corps engineer assets must be available and prepared to respond. The availability of a corps airborne combat engineer battalion and an airborne light equipment company are essential to provide corps engineer flexibility. The multitude of successful Vietnam tactical airfield construction/repair operations was in part due to the extensive experience gained and techniques developed during the testing of the airmobile division. This same capability has long been a primary capability of the airborne division. Such experience and tactical expertise must be maintained by active, repetitive training programs focused on Middle East contingency missions.

The size of the engineer force supporting the TFOB is mission dependent, but should not be less than one platoon. This is in addition to the engineer equipment package required to support the TFOB. A platoon size element gives the TFOB commander sufficient capability to provide minimal mobility taskings during the initial defensive operations in order to release maximum engineer assets to countermobility requirements. The engineer platoon leader likewise provides the minimal level of engineer advice to the commander. As the size of the TFOB increases, so should the level of engineer expertise and support.

Equipping the System

Current engineer thought for contingency mobility operations provides minimal countermine capability. This shortfall should be reviewed. We have concluded that the major engineer equipment requirement in mobility operations would occur in support of offensive operations: the breeching of minefields or possible obstacle reduction. Limited obstacle reduction should pose no problem if sufficient engineer equipment is provided to the TFOB. This would most likely occur in conjunction with MSR improvement or expansion. The breeching of minefields is a problem with the system today. The only mine clearing equipment reasonably available today in support of contingency operations is:

- A soldier with a bayonet
- Bangalore torpedos
- Mine detectors

The product improved AN PRS-7 mine detector now has a high probability of detection of metalic - nonmetalic mines in arid, desert type soils.[25] Regrettably, all three methods mentioned require soldier exposure to enemy fire. As in the mature theater, there is a valid requirement for stand-off assault breeching equipment to support contingency operations. Air-mobile tactics may dictate the assault of an enemy position -- strongpoint, artillery battery or rear area installation -- in which a protective mine-field configuration of some type is present, and would have to be breeched.

A portable mine neutralization system (POMINS) is urgently needed for light force use against anti-personnel (AP) mines and wire obstacles. The current developmental POMINS has an Initial Operational Capability (IOC) estimate of FY86, an unacceptable time interval. Since POMINS is a US improved version of an existing Israeli system, an interim solution is to procure sufficient Israeli POMINS to support Middle East contingency plans.[26]

Additional investigation should explore helicopter delivered line charge systems, either sling load delivery or fired from the helicopter. The current developmental anti-tank (AT) mine clearing line charge (MICLIC) has an IOC of FY83.[27] Adaptation to sling load delivery should be a simple matter. The use of the helicopter as a MICLIC firing platform, with both AP and AT breeching capability, may have merit. Firing time could leave the helicopter vulnerable, but no more so than delivering a TOW missile with a 18-23 second tracking time.

The Vehicle Mounted Road Mine Detector System (VMRMDS) must be part of the engineer contingency operations equipment package. Capable of being mounted on a 1/4 ton or larger vehicle, its value to contingency operations is substantial.[28] The continual requirement for daily engineer road clearing missions in Vietnam adequately support the item in the contingency force package. In some desert terrain, the VMRMDS can provide off-road mine detection capability in support of potential mechanized operations as the theater develops.

The development and fielding of scatterable mine systems intensifies the problem of minefield detection in that detection now becomes a near real-time requirement. Currently, mine detection capability in the contingency corps is centered around the following:

- Division All-Source Intelligence Assets
- Tactical Reconnaissance
- Sensors
- Visual Observation
- Inadvertant Mine Detonation[29]

On-going efforts could substantially improve the standoff detection capability, but need priority and funds. In the near term, developmental efforts by the US Army Mobility Equipment Research and Development Command (MERADCOM) to produce an updated users guide to imagery interpretation would be a considerable capability increase for all-source use.

Clearly the most promising package in the conceptual inventory is the Airborne Minefield Detection System (AMIDS). It consists of an electro-optical sensor system mounted in a Remotely Piloted Vehicle (RPV).[30] The concept also envisions a near-real time feedback capability. Such a system would not only provide the necessary data for defeating conventional mine operation, but could possibly negate the dynamic effect of scatterable minefields. The potential also exists for additional application of AMIDS to:

• Perform rapid MSR clearing operations in the Division and Corps rear without extensive committment of engineer personnel and time.

• Countermobility use to assist in the placement of or location of friendly scatterable minefields delivered in the course of the battle.

Navigational aids are also an equipment requirement of great importance in desert operations. Specific devices and techniques will be discussed as part of the training section of this chapter.

Manning the System

An inherent task in countermine operations is reconnaissance. The necessity for a strong reconnaissance capability is repeatedly documented in WWII after action reports as significantly key to successful arid mountain/desert warfare. The Germans in North Africa, after finding themselves initially unprepared for fighting in the desert, developed considerable emphasis on reconnaissance. In one instance, three reconnaissance squadrons were formed into a reconnaissance brigade and placed directly under Army headquarters control.[31] Although concerned primarily with enemy intelligence activities, engineer intelligence -- terrain analysis, trafficability conditions, water sources, and minefields -- were also part of the information gathered by these units.

The Soviets rely heavily on engineer reconnaissance as a key input to the commanders decision process.[32] The Soviets have placed reconnaissance capability in the organic division engineer battalion in the form of a reconnaissance platoon. The platoon conducts basis engineer reconnaissance and is also capable of NBC survey.[33] Soviet doctrine stresses engineer presence in all tactical reconnaissance organizations, and the employment of engineer reconnaissance elements well forward of deployed Soviet formations.

Historical lessons learned substantiate the necessity for expanded engineer reconnaissance capability in desert/mountain operations. We conclude that current reconnaissance capability in units most likely to be committed to Middle East contingency operations is insufficient. Minimal capability is present in the engineer reconnaissance teams in divisional engineer battalions. The positions however are rarely filled. When the positions are filled, the personnel simply do not have the requisite experience and training to operate in the Middle East environment. Subject matter such as recognition of salt flats, soil bearing capacity of various terrain for tactical airfield construction and the location of water sources must be included in reconnaissance section and personnel training programs. Although the all-source intelligence capability at division and corps integrates engineer terrain analysis capability, the need for provision of bottom-up, real-time engineer EEI to the all-source operation is essential. It is our conclusion that existing sources, engineer and maneuver, do not adequately provide this intelligence. Our research strongly suggests that an expanded reconnaissance capability is needed - possibly a separate platoon within the corps engineer force structure. Further evaluation in this area is warranted. Other subjects to be considered are:

• Development of an engineer reconnaissance NCO course, consisting of a core program of instruction. Additional blocks of instruction would be developed for regional contingency areas. Geological instruction for training in water source location would be included. A 12B CMF prefix designation should also be awarded.

• Development of mission area training literature and scenarios for use in sustainment training of reconnaissance personnel.

• Periodic exposure of reconnaissance personnel to actual or similar Middle East environment for extended periods.

• Emphasis in the stabilization of reconnaissance personnel in unit positions.

Training for Employment of the System

Three areas need comment and discussion in regard to training for Middle East mobility tasks; navigation, night operations, and battle drills. The need for desert navigation training is equal in importance to a strong reconnaissance capability. Few if any units in the Army are prepared to navigate in desert type environments - an environment marked by lack of reference points, a scarcity of key terrain and extreme conditions such as sandstorms and thermal haze. The need for geographic information to navigate is great and harder to obtain than in other kinds of terrain. Desert maps may show a pattern of ground structure, such as the direction in which dunes and wadis lie and their general range. Maps are also a useful guide to movement and route selection. Air photos may give up to date information and details of position which compliment the map.[34] The Israelis believe photo strip maps are the ideal navigation method to use in the desert. Nevertheless, navigational expertise and navigational equipment is needed, not only vehicular, but individual compasses as well. Many types of navigational aids have been tried -- aircraft compasses with magnets to correct deviations (German); sun compasses (German and British); and vehicular gyro type devices (Russian). Advantages and disadvantages have been experienced with all . . . but our historical research substantiates the absolute requirement for both personal and vehicular navigational aids. Additional navigational techniques -- resection methods, homing beacons and the employment of radar to establish bearing -- must also be taught. Training in the use of such techniques and practice in sustaining the skills is most important.

The difficulty in navigating in the desert is best illustrated by Israeli experience in the training program given engineer officer candidates. Fully 35% of the candidates are attrited in the engineer officer basic course -- even after an intensive three week preparation course in desert navigation and orienteering--as a result of navigational inability.

A number of navigational equipment programs are currently under development. They are:

- Combat Vehicle Heading Reference System (Engineering Development)
- Miniaturized Gyrocompass (Exploratory Development)
- Forward Area Positioning System (Exploratory Development)
- Position and Azimuth Determining System (artillery) (FY82 IOC).
- Point Positioning and Land Navigation (Operational Testing Complete 1978)

The systems cited are costly and far exceed the capability required for normal engineer operations. There is also a lengthy time before such systems would be fielded. Current technology exists however for odometer controlled, ground locked navigation systems which can provide 300 meter accuracy over a 100 kilometer traversed distance, yet are still in a reasonable price range. The USMC has conducted extensive testing in this area.[36] Such devices should be provided to the contingency corps engineer organization today. Regardless of the system/device provided, training is paramount to successful desert navigation.

Training for night operations is an important aspect of desert/mountain operations. Security, surprise and deception are obvious reasons for night training. Night operations also allow engineer tasks to be accomplished during cooler periods, increasing efficiency and reducing fatigue. The Israeli's spend approximately 35-40% of infantry - armor - engineer basic training in desert night operations.

The idea of battle drills is old - the techniques change with the tools of warfare. WWII minefields in Africa were the primary obstacle to mobility and forced the methods of attacking/breeching the fields to become a major training subject. In most units a standard mine clearing drill was established and the drill's implementation pursued vigorously in intensive training exercises conducted behind the lines. The drills were practiced day and night with variations made by the commanders as necessary.

Soviet countermine battle drill is structured to present a "rolling wave" effect whereby movement support detachments (with Engineer/Infantry composition) are broken into two or three groups. As one group attacks an obstacle such as a minefield, the following group passes through to attack the next.[37]

The Israeli Army has developed a structured battle drill for employment against obstacles/barriers of various complexities.[38] The composition of one such drill adapted for airmobile use is shown in Figure III-5.

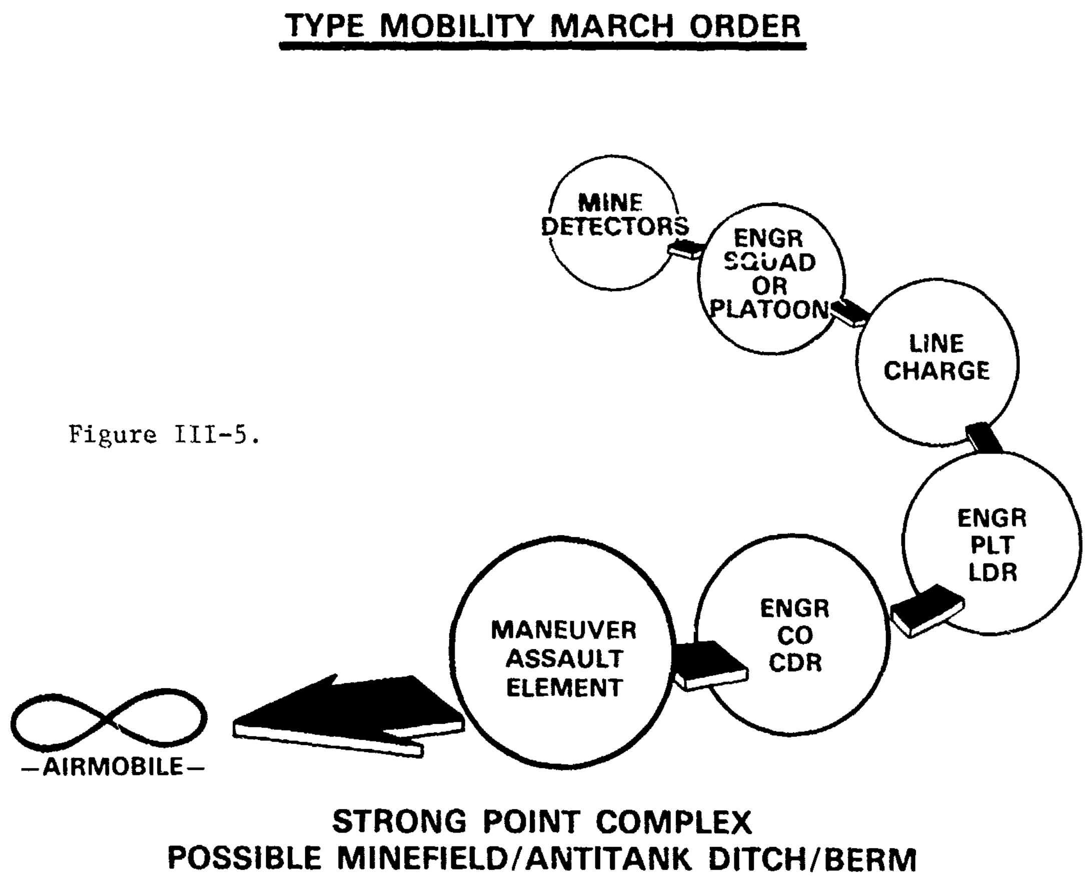


Figure III-5.

The Israeli drill is a combined arms drill, pulling together infantry, armor and artillery in support of the engineer breeching operation.

For US light infantry/airborne/airmobile forces, battle drills have applicability in mobility contingency operations as well as in the countermobility role. The use of helicopters to support mobility breeching operations needs to be developed. Helicopter delivered line charges, supported by attack helicopter suppressive fires or the use of ground emplaced POMINS systems all have the potential for development of battle drills. While the helicopter may provide only the delivery means, the sequencing of engineer, infantry, and firepower assets and the airmobile training necessary to accomplish missions such as strongpoint breeching operations must all be integrated into the training program.

CONSIDERATIONS/RECOMMENDATIONS

The mobility discussion has been presented on the assumption that requirements for engineer support of mobility operations would occur primarily in an offensive role, or in the transition from offensive to defensive tactics. Minimal but definite requirements exist to support the ground logistical mission within the TFOB and the corps support base. Within this framework, the following considerations/recommendations are reiterated.

- Engineer equipment capability is currently available to support TFOB and corps support base operations. The extent of the TFOB's supported will dictate additional support requirements from a corps airborne combat engineer battalion and light equipment company in the initial phases of deployment. Lack of airmobile assets in combat, combat heavy battalions would preclude their use in the initial phases of deployment.

- Current countermine capability for the contingency corps needs to be improved and the shortfall corrected. Minimal improved anti-personnel breeching capability is a must. Purchase of Israeli POMINS systems as an interim item should be pursued.

- Additional mine breeching capability should be considered utilizing helicopter landed or helicopter air-delivered line charges, specifically developed for Middle East contingency use.

- The Vehicle Mounted Road Mine Detector System (VMRMDS) should be priority issued to selected engineer contingency corps units.

- The MERADCOM imagery interpretation users guide needs priority emphasis to significantly improve the capability of terrain analysis specialists within the all-source intelligence cells at division and corps levels.

- The Airborne Minefield Detection System (AMIDS) could provide the most significant mobility enhancing capability for the engineer system in the near term, for both light and heavy units. The system should receive expedited funding.

- The Reconnaissance capability of the Contingency Corps needs to be improved. Consideration should be given to:

  .. A Corps Engineer Reconnaissance Platoon

  .. A Reconnaissance NCO Course with mission area training included for the Middle East.

  .. Development of mission area training literature and scenarios for sustainment training of reconnaissance personnel.

  .. Environmental training in comparable middle east terrain for reconnaissance personnel.

- Arid desert/mountain navigation training needs increased emphasis in mission area training.

• Individual personnel and vehicles need better navigational aids. Unit level navigational systems are also needed.

• Engineer airmobility training needs expanded emphasis.

• Battle drills, utilizing helicopters in breeching/airmobile operations need to be developed in conjunction with combined arms training.

• Night training for engineers targeted for Middle East contingency operations should be intensified.

CHAPTER III

FOOTNOTES

1. US Army Training and Doctrine Command, Combined Arms Combat Development Agency, Concept for Contingency Corps 86 - Coordinating Draft, p. 3.

2. Ibid., p. B-1.

3. Ibid., p. 1-4.

4. United Kingdom Ministry of Defence. Land Operations - Volume V - Part 3 - Desert, p. 6. (hereafter referred to as "Land Operations").

5. Alfred Toppe, G. Desert Warfare - German Experiences in World War II, p. 3.

6. Engineer Agency for Resources Inventories, "North Africa," Appendixes, in Landmine and Countermine Warfare. Washington: 1972, Vol. 4, p. B-1. (hereafter referred to as "North Africa").

7. Ibid., p. C-3.

8. Toppe, p. 39.

9. "North Africa," Vol. 3, p. 21.

10. "North Africa," Vol. 3, p. B-7.

11. Ibid., p. A-1.

12. Interviews with Israeli Engineer Officers, Israeli Defense Forces, Tel Aviv, Israel, February 12-25, 1981. (hereafter referred to as "Interviews").

13. "North Africa, Appendixes," Vol. 3, p. M-1.

14. Toppe, p. 3.

15. Ibid., p. 69.

16. "North Africa, Appendixes," Vol. 4, p. B-5.

17. "Land Operations," p. 43.

18. "North Africa, Appendixes," Vol. 4, p. B-7.

19. Toppe, p. 10.

20. "North Africa," Vol. 3, p. 84.

21. Toppe, pp. 3-4.

22. John, Lilita Dzirkals and Barton Whaley, Timely Lessons of History: The Manchurian Model for Soviet Strategy, pp. 63-64.

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27. Ibid., pp. 49-50.

28. Ibid., pp. 35-36.

29. "Corps 86," p. 62.

30. "Systems Handbook," pp. 13-14.

31. Toppe, p. 23.

32. P. Diky, Colonel, "Engineer Support of a March," Soviet Military Review, October 1976, pp. 20-21.

33. Donnelly, p. 194.

34. Cohen, pp. 379-381.

35. US Army Engineer Topographic Laboratory, Current Research and Development, pp. 49-59.

36. Interview with Cervarich, US Army Engineer Topographic Laboratory, Fort Belvoir, Virginia, 10 April 1981.

37. L. Kazmin, Colonel, "Engineer Support of Attack in Mountainous Country," Soviet Military Review, March 1969, pp. 29-31.

38. "Interviews."

CHAPTER IV

COUNTERMOBILITY

General.

In the desert/mountain contingency environment, the key to successful execution of the engineer countermobility role is mobility. Engineers need a mobility capability to move about the battlefield under real-time response to mission requirements. If engineers do not have the necessary mobility, the capability for countermobility will be ineffective. This mobility equivalence requirement must be a fundamental input to the commanders planning process and its full impact considered at the beginning.

In the contingency corps operating environment, the optimum threat is a Soviet heavy force. The use of engineer countermobility resources are key to disrupting and halting the threat. One essential element for success against the force is the selection and reinforcement of a terrain barrier to stop, delay and destroy the threat.[1] Such terrain barrier locations are relatively easy to select in the mountains -- the desert presents a much more difficult problem. The only method for providing such a barrier in the desert is for the engineer to create one. The difficulty of that task is amply defined in current British desert doctrine:

> The main characteriscic of the desert as an operational area is that it produces nothing for the support of the Army: every article for life must be carried there.[2]

Engineer countermobility operations will be focused on the following:[3]

• Mine warfare; the use of mines, both conventional and scatterable to:

.. Deny terrain

.. Disrupt enemy movements

.. Isolate an objective

.. Interdict reserves/reinforcing forces

.. Disrupt/delay threat retrograde

.. Protect flanks and rear

• Partitipation in across the FEBA operations into threat rear areas.

• Creation of a variety of other obstacles to both vehicular and personal movement.

• Provision of ADM support to forward deployed forces.

In mine warfare, the capability of the contingency corps to remotely deliver mines is a major contributor to countermobility operations.[4]

Mountain countermobility operations present a number of options - minefields, craters, landslides, and anti-tank ditches. Desert operations are much more limited - most likely to minefields and anti-tank ditches, and would be employed if the force defended/delayed to successive strong points. Airmobile countermobility operations launched from TFOB's are ideally suited to conduct the operations described in both the desert and mountains. However the force is employed, engineer elements committed as demolition teams, squads or platoons, will be essential. It is conceivable that platoons from the corps combat engineer battalions could be attached to or placed in direct support of a TFOB to augment the organic divisional engineer elements. Given space constraints in TFOB's, it may be prudent in some cases to augment with engineers in lieu of infantry platoons to increase countermobility capability.

LESSONS LEARNED

As in mobility, a wealth of lessons learned have been gathered through historical research, literature research and observations from travel and interviews.

- Ancient forts and posts cover important avenues of approach - dominate ground of tactical importance.[5]
- Key terrain may be scarce . . . many features can be by-passed (desert). Certain areas, water sources, airfields and suitable airfield sites, dominant ground and centers of communication may have to be held.[6]
- Defensive operations are conducted in considerable depth and organized around strong points. Desert strong points are sited for all around defense, including anti-tank mines.[7]
- The desert lends itself to great ingenuity in mine warfare but . . . logistics tonnages and engineer resources are limiting.[8]
- Standardization of minefield marking, records and reports is absolutely essential.[9]
- Construction of roads in the desert is a lengthy and extremely difficult process due to the distances required to transport materials.[10]
- Minefields provide a good substitute for terrain obstacles.[11]

- Random mining on key roads has a profound effect on operations.[12]
- Mine warfare in the desert has two problems.
  - .. Emplacing mines in cemented/gravely soils leaves an obvious signature.
  - .. Drifting sands can cover buried mines so deeply as to render them ineffective or . . . expose buried mines.[13]
- The Germans increased effectiveness in defile mining operations by not following set patterns and placing more than one mine in the same hole.[14]
- The Germans in North Africa defended strong points in the mountains with minefields and the heavy use of booby traps.[15]
- The coverage of minefields by fire was so effective that it required super-human feats by engineers in order to breech.[16]
- Conventional mines, surface layed and properly camouflaged are as effective as time consuming, conventionally emplaced minefields.[17]
- The Germans in North Africa experienced many personnel losses when moving back through their own inadequately marked minefields.[18]
- Wadis should be mined . . . particularly at their crossing points.[19]
- The mining of airfields by scattering mines indiscriminately is effective for only a short time.[20]
- Freshly laid minefields can be detected by air photos or ground observation; however, information on depth and density is difficult to determine.[21]
- Extensive use of dummy minefields is beneficial to conserve mines or increase the danger area protecting new positions.[22]

• Featureless terrain without easily locatable landmarks makes finding and removing friendly minefields difficult.[23]

• Desert strong points could be manned by few troops if adequately mined and covered by fire.[24]

• Nuisance mining in the enemy's rear is extremely disruptive, particularly the sporadic mining of long stretches of road.[25]

• Proper sight selection for minefields is imperative . . . ground reconnaissance is the only solution, by both maneuver and engineer personnel.[26]

• Abandoned military equipment and stores may be booby-trapped.[27]

Employing the System.

During WWII, over one million mines were employed in the Northeast area of Libya.[28] The Syrians emplaced over 2½ million mines in the Golan Heights of Israel prior to 1967.[29] The previously listed lessons learned concentrated on the use of land mines in the mountains and the desert. Will US forces in the 1980's, if committed to the Middle East, use land mine warfare to the extent it was 40 years ago? The answer is probably not due to the logistical requirements and the inability to get the munitions to the theater in any volume near the densities used in WWII. Nonetheless, mine warfare can still be a decisive factor. Scatterable mines will become the major contributor to engineer effort. However, current doctrine for the employment of scatterable mines is fragmented. There are major doctrinal disconnects in the employment of the Family of Scatterable mines (FASCAM). The development of the doctrine has been sent piecemeal to the users in the field. The M56 helicopter system, fielded in 1977, still does not have a standard doctrine for employment. Other systems such as the artillery delivered RAMMS (anti-tank) and ADAM (anti-personnel) are scheduled for deployment into Europe in FY82.[30] Service schools are to provide instruction in the employment of RAMMS and ADAM, but fundamental questions of basic load issue and use of long self destruct times are not yet answered. The Gator system, an Air Force delivered scatterable mine system, is not funded for production until FY84.[31] Although contingency corps doctrine states that scatterable mines will be a major contributor to countermobility operations, the fact is that we simply do not have the scatterable mine systems fielded to support the concept.

Proponency is partially to blame for creating the doctrinal disconnects. For artillery delivered systems, the RAMMS and ADAM, the artillery's mission is finished once the round clears the tube. The Interim Draft of FM 90-7, Obstacles, states that only minefields with over a 24 hour duration will be marked.[32] The document does not state who does the marking. Other references state that artillery delivered systems will not be marked.[33]

The doctrine for employment of FASCAM systems also neglects to address in sufficient detail the method and channels by which the planning process is accomplished. A good comparison is the use of the air force tactical air request net. As a request for air support is transmitted to the approving authority, intermediate headquarters signal consent by silence. No such defined system exists for use of the M56 or artillery delivered scatterable mine systems. As a result, engineer lieutenants arriving in a unit are not sufficiently knowledgeable to advise a supported commander on the employment of any scatterable mine system.

Minefield reporting procedures for scatterable systems are ill-defined also. Requesting commanders are directed to prepare DA Form 1355-1 for those minefields with a duration over 24 hours. It is our contention that neither the maneuver commander nor his staff will likely attend to that administrative detail. More than likely, the attached/supporting engineer will assume the mission.

There is currently some student evaluation of the FASCAM requesting/reporting system on-going at Fort Leavenworth under the aegis of the Combined Arms Combat Developments agency. The student projects should be used as a starting point to get defined procedures for FASCAM employment into the hands of the users. Peter W. McDavitt best summarized the doctrinal need in an article in National Defense.

> What is required is a dedicated group of officers representing all the combat arms and the Corps of Engineers to develop the concepts of use for scatterable mines. Doctrine, tactics, selection of denisty, command and control, operating procedures, delivery alternatives, logistics, minefield recording, training and so on need to be fully developed, institutionalized, and understood throughout the Army's training establishment, operating units, and command structure. Unless and until this substantial effort is made, the total capacity afforded by scatterable mines is unlikely to be fully realized.'[4]

If we accept the assertion that the contingency corps capability to remotely deliver mines is a major contributor to countermobility operations, McDavitt's recommended action is a major area for doctrinal attention now.

Consideration should also be given to a review of the standard mine laying and recording procedures. The requirement for detailed preparation of DA Form 1355, in multiple copies is an excessive burden on the emplacing units. In desert terrain, the lack of features upon which to accurately locate the minefield exacerbate the problem. The use of photos, position-locating navigational equipment and other means should be pursued to eliminate the administrative requirement for minefield recording from the emplacing unit.

Similarly, the method of emplacing conventional minefields should be reviewed. The inability for the soldier to accurately locate himself in the desert would seem to negate the effort needed to emplace conventional fields. The Germans in WWII used a system of minefield panels - a rectangle of variable size which always contained 24 mines. The density of the field could be varied by varying the size of the panel. Drills were utilized to train soldiers in placing the panels. Individual mines were not recorded, but panels were recorded as accurately as possible given the featureless terrain.[35] A series of such panels is depicted in Figure IV-1.[36]

DELIBERATE MINEFIELD PATTERNS

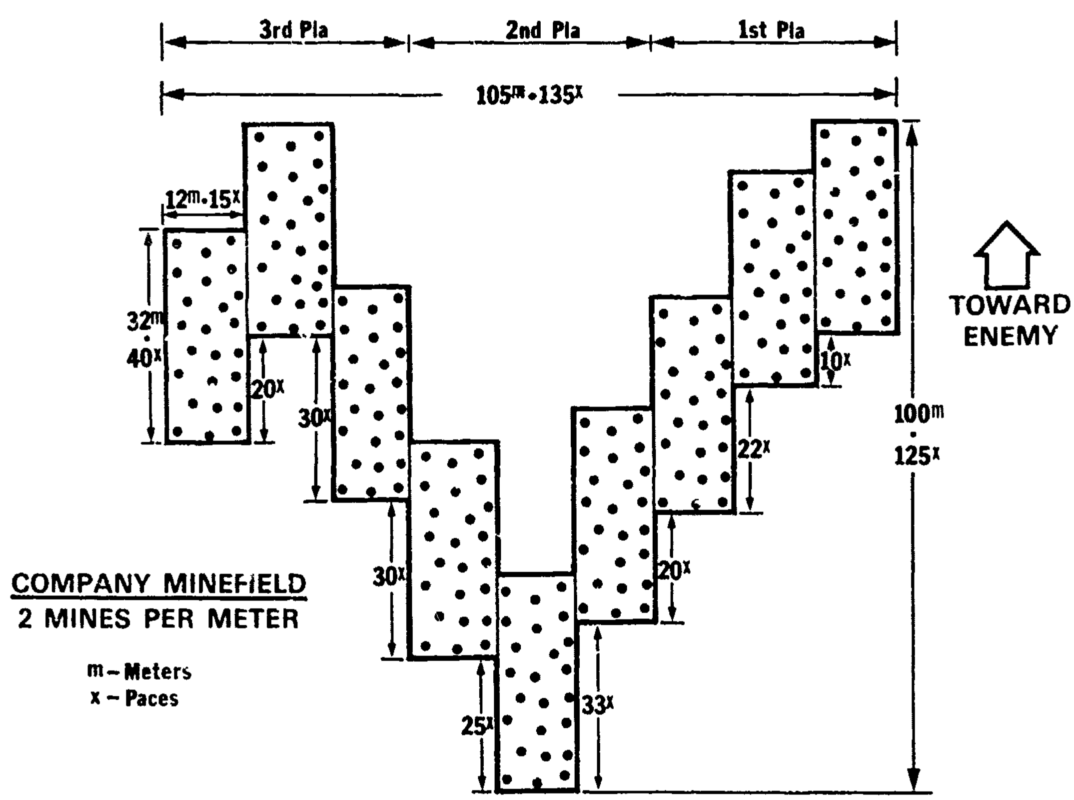

Figure IV-1

Although countermobility operations in a mid-east environment will probably rely primarily on scatterable systems, the placement of conventional minefields will still be required, particularly as time in theater progresses. Potentially, the German method of panel emplacement may provide an easier, simplified method. Again, location of panels could be aided by the use of position - navigations aids or aerial photos. Any method which can save the emplacing engineer time should be pursued. Conventional mine use will have great applicability in the establishment of deliberate battle positions or "kill zones." This tactic, a variation of ambush techniques along defiled sections of roads, require a method of sealing the attacked column within the zone. Rommel, in the El Alamein operation in WWII, used mines with great effectiveness in his "Hollow Garden" defenses - which were the first modern day version of deliberate battle zones used in tank warfare.[37] The Soviet armor heavy threat will require the same methods. If conventional mining is used, we must be able to emplace quickly, record easily and retain the record for possible ground movement back through the area by friendly forces.

In an evaluation of mine warfare doctrine, particularly with FASCAM use, the levels of authority for emplacement should also be reviewed. Communications difficulties over great distances could make such decisions critical. The TFOB structure probably needs delegation authority for all mining operations to that level.

The initiation of any conventional mining operations will stretch engineer assets to the limit, particularly if there are competing demands such as demolition and other obstacle requirements. From a doctrinal stand point, the issue of work division between engineers and other arms has never been specifically addressed in other than general terms. The Soviets have addressed the issue <u>and</u> have developed doctrinal guidance. If Soviet forces are halted 24 hours or more, combat troops supply the following percentages of available troop personnel for countermobility employment under engineer staff supervision.[38]

- Motor rifle 70%
- Artillery 60%
- Tanks 50%

If such guidance was issued to US commanders, the quantification of capability over time for specific obstacle emplacement could be better articulated to the maneuver commanders by engineers at all levels. In the mountains/desert, particularly in the early phases of deployment, this command guidance is necessary and should be stressed. It has specific TFOB applicability.

In 1979, CPT Henry Leonard, USA, and Mr Jeffrey Scott conducted an analysis for the DOD Program Analysis and Review Directorate on estimating movement rates in mountainous terrain with and without obstacles.[39] The study is an excellent basis for planning purposes in determining the engineer requirements for countermobility operations. The analysis has application to some desert areas. The study first drew some comparison between NATO and Contingency Operations:

- NATO - obstacles enhance effectiveness of defensive forces
- Contingency - obstacles could impose a strategically significant delay.
- Contingency - obstacles could be effective without cover due to paucity of by-pass means.
- Contingency - assign the mission of disrupting enemy obstacle reconstruction efforts to tactical Air Forces.

Leonard's and Scott's thesis is that the primary mission of the obstacle effort is to eliminate the threat of an enemy breakthrough, and that the engineer placement of major obstacles is key to this effort. The authors suggest initial engineer effort as high as 30% of the mission force instead of the usual 5-10%. We strongly agree with the conclusions of that paper. In application, this would mean the committment of platoons from Corps Engineer battalions to the TFOB. Leonard and Scott estimate that in mid-east mountainous terrain, one day of effort per engineer plattoon can produce 2 days of delay. Said another way, one battalion day of effort on four major routes, could provide six days of delay.[40]

Consideration must be given early in the planning process as to the level of effort to be expended in specific categories of engineer countermobility operations such as mine and demolition missions. This effort is directly related to the logistical capability to support such operations. Of paramount importance is the logistical ability to deliver FASCAM/conventional mines and explosives to the theater and thence to using units within the theater. Theater delivery of these items directly impacts the corps obstacle plan. We tend to address FASCAM employment as if it were available in unlimited quantity. The mix of artillery rounds in contingency basic loads will now impact on the corps obstacle plan and the flexibility of the maneuver commanders. As part of the development of doctrine for employment, engineers need planning figures for employment of the various countermobility systems.

Equipping the System

With the airmobility thrust of the contingency corps, the engineer must consider some specific items of equipment to properly support employment of engineers in the countermobility role. These are:

- Local ground mobility
- Cratering systems
- Light-weight explosives
- Helicopter delivered mine dispensing systems (or equivalent)

Airborne/airmobile forces for years have used small, lightweight platforms (MULES) to provide ground mobility for equipment. The demands for such items in a Middle East contingency environment will be great.

Consider an engineer platoon on a mission to destroy a bridge in a mountainous area where helicopters cannot deliver explosives close to the site. Bridges less than 400 feet could require 800-2000 lbs of explosives. Attempted landslides could require more. Mules, motorcycles with trailers, Bobcat material handling devices, three-wheel dune buggies or similar items are needed additions for conserving troop strength, particularly in the hotter climates. Although on-going investigations are looking at this, they need to be immediately available now to engineers subject to mid-east contingency missions.

Cratering systems such as the M180 currently scheduled for USAREUR fielding in FY81 are urgently needed for contingency operations. These systems are by far better than the current shaped charge/cratering charge sequential method. The capability needs to be given now to the logistics packages of contingency units.

Lightweight explosive technology needs additional emphasis and funding for contingency related stocks. Blasting Agent, a bulk explosive slurry which has 1.5 times the excavating energy of TNT will provide an improved capability if it can be packaged for contingency operational use.[41] Mixing and excessive water requirements are its major drawback. Blasting Agent (BA) is scheduled for fielding in FY82. Since BA is military version of a commercially successful bulk explosive, the Army should expedite testing and research of additional explosives. Improved explosives can provide a quantum jump in engineer (and combat arm) countermobility capability with a corresponding decrease in logistics requirements.

The M56 helicopter mine system needs to be added to contingency corps units in numbers now. It is the only fielded system we have, the only one engineers have worked with and definitely the only capability that can be deployed today. Other systems in development put the contingency corps in the position of facing an existing threat with possible solutions. The Air Force system, Gator is two plus years away from fielding. Volcano, the Army follow-on system is seven plus years away from fielding. The fielding of artillery delivered systems is a function of production schedules and priority fielding plans. The current void of such systems for contingency corps operations is the most critical shortfall in the countermobility system.

Although helicopter or air delivered mine emplacing systems are the desired equipment for Middle East contingency operations, there is also need for improved ground mine emplacing systems. The most important of these is the Modular Pack Mine System (MOPMS) which is a man portable

AT or AP system for rapid emplacement of small minefields.[42] Unfortunately, the fielding date for this system has slipped from FY84 to FY86. The system is important because it can be emplaced by all combat arms personnel, giving the complete capability for mine emplacement to all units in support of their tactical missions.

The Ground Emplaced Mine Scattering System (GEMSS) is a trailer mounted mine dispenser which is currently planned for limited issue to airmobile and light infantry divisions.[43] GEMMS may have increased use potential as the contingency theater develops, but its potential in the first 30 days is limited by its mobility, and requirement for a prime mover. The GEMSS Auxiliary Dispenser (FLIPPER) which can be mounted on a 5 ton Dump Truck may provide an alternate mobile dispensing system, however, testing is necessary to determine its potential use for Middle East contingency operations.

Anti-tank ditches may have limited use in the contingency role, particularly in the early defensive stages. The ability to dedicate airmobile lift to moving such equipment may not be worth the benefits gained. Digging in many of the gravely areas would require demolition support. The time/effort expended is probably not worth the benefit except in specific situations.

Training in the System

Specific tasks to support engineer training for countermobility operations is adequately covered in current SQT publications. What is needed is mission area training connected with those demolition/mine emplacement/ obstacle preparation tasks. The specifics of landslide demolitions, cratering in defiles and other terrain obstacles must be taught at the squad level for units involved in mid-east contingencies. Training to execute such tasks in mountain or desert areas requires extensive detailed training; neglect of that detail will degrade the mission until the experience can be accumulated with an on-the-job type program. In a contingency environment, delay could seriously affect force mission accomplishment.

As in mobility operations, reconnaissance training and capability and airmobile training are key elements of the countermobility training package.

Battle drills have application as well, from the stand point of attaining engineer efficiency in accomplishing specific tasks - cratering, type demolition emplacement.

In airmobile operations, the speed of troop employment, time on the ground, and thorough knowledge of specific individual tasks are all fundamental to success. The more efficient such operations can be executed by engineers for countermobility tasks simply increases the number of targets emplaced over a given period of time. Battle drills oriented to such countermobility tasks should be a major part of engineer training programs. The integration of combined arms participation into drills, such as security and air defense, must also be practiced.

Engineer Tactical Considerations.

Countermobility operations must have two essential elements present, whether provided by the engineer unit involved or by the supporting combat arm. These two elements are local job site security, and air defense protection for critical job sites. Given a heavy soviet threat, it can be expected that heliborne operations, lead ground reconnaissance elements and other interdicting forces will harass and hamper engineer effort. The engineer must be integrated into the combined arms command structure, must have total knowledge of what is available and how to get it, and must make these requirements known to the maneuver commander.

From a corps stand point, this becomes critical when evaluating the committment of corps engineer battalions to the countermobility role within division sectors. Anti-tank guided missle support also becomes a factor for consideration. Recent war gaming at Fort Leavenworth has shown that in some instances the committment of engineer platoons in lieu of infantry platoons produces the best gaming attrition results on threat forces in a mountainous countermobility environment. More analysis is needed for specific contingency plans in order to determine the level of Corps Engineer support which would be desirable.

Special Aspects.

There exists further possibility for engineer contribution to defensive contingency roles the attachment of engineer platoons (ideally corps platoons so as not to degrade divisional capability) to Special Forces teams and Ranger battalion operations. Engineer units, squad, or platoon can provide an extremely valuable capability to the overall Corps Contingency force. But -- the key is training in peacetime with the employing elements -- not specialty, change of pace training, but mission oriented, mission area training for specific contingency use. To attempt to employ the capability without the training would be disasterous to men and mission.

CONSIDERATIONS/RECOMMENDATIONS

The role of the engineer in contingency operation is probably most significant in the area of countermobility employment. Given the proper equipment and trained to the level necessary for mid-east employment, the engineers contribution to defensive, delay operations is absolutely critical to mission success. In summary, the following considerations/recommendations are reiterated:

- FASCAM doctrine needs immediate attention to eliminate disconnects in employment procedures and techniques.

- Mine warfare doctrine for contingency roles, specifically the mid-east needs review in the areas of emplacement, recording, and delegation authority.

- World War II techniques of minefield emplacement (German) should be analyzed for mid-east environment application.

- Doctrinal guidance on how much non-engineer effort is available for countermobility operations should be developed. This area has mature as well as contingency theater application.

- Engineer force structure requirements can be developed utilizing days of engineer effort vs days of delay gained. This should be a starting point for contingency corps planning.

- FASCAM basic load mixes will drive logistics requirements and impact on conventional mine and explosive availability. Guidance/standards are needed.

- Ground mobility platforms in numbers are needed for engineer use in job site preparation.

- Cratering systems, e.g. M180 Systems, need immediate procurement and issue to contingency corps units.

- Lightweight explosives have significant potential for contingency corps use. Commercial products need evaluation for immediate procurement for contingency use.

- The contingency corps needs an operational FASCAM system such as the M56 helicopter mine dispensing system (or equivalent) now. This is the primary engineer shortfall in the contingency corps countermobility equipment area.

- Engineer mine/demolition training specific to the mid-east needs strong emphasis.

- Reconnaissance/airmobility and battle drill training for countermobility application in mid-east scenarios needs attention.

- Employment of engineers in countermobility roles requires augmentation of air defense, security and ATGM assets.

- Engineer employment in Special Forces and Ranger operations for mid-east contingencies should be actively pursued.

- MOPMS mine dispensing systems should be funded and issued to contingency corps designated unit

CHAPTER IV

FOOTNOTES

1. US Army Training and Doctrine Command, Combined Arms Combat Development Agency, Concept for Contingency Corps 86 - Coordinating Draft, p. 4. (hereafter referred to as "Corps 86")

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5. "Land Operations," p. 6.

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22. _Ibid._, p. 25

23. "Construction in the Desert," pp. 3-8.

24. "North Africa," Vol. 3, p. 42.

25. _Ibid._, pp. A-12, B-7.

26. Ibid., p. B-1.

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CHAPTER V

SURVIVABILITY

General. The terrain spectrum of arid mountains, rocky plains, sand dunes and salt flats presents to the military planner an area of contrasts, extremes and challenges. Accomplishment of the tasks of the survivability mission are made all the more difficult by this land of contrasts and extremes. The differing aspects of the desert - landforms, vegetation, climatic conditions, geological variances, varying shades and hues of bland colors, varying degrees of water availability and a dearth of construction materials - presents to the engineer an entirely different scope of considerations for this mission. It differs drastically from conditions on the European landmass - his normal set of parameters for survivability.

Survivability tasks are:[1]

- Development of Protective Positions
- Countersurveillance Measures, which consist of:
  - .. Camouflage
  - .. Deception
  - .. Smoke

LESSONS LEARNED

These lessons learned in survivability were gathered from historical research, current literature, observations and interviews from research and travel.

Protective Positions.

- The individual slit trench for the soldier - dimensions of 1½ times body length and at least waist deep - has proven to afford the best protection in desert areas.

- Slit trenches, communication trenches and small unit trenches were normally not bermed. Such mounds of earth normally gave away position location in the flat desert terrain.[2]

- In the conduct of rapid, mobile warfare in terrain where digging in is difficult, dispersion offers a better solution. One can still take advantage of existing terrain relief - concealment and masking - if such is available. German experience indicated 50-100m between dispersed vehicles.

- The German Army in the construction of larger field fortifications in the flat desert kept the position elevation at ground level with no berms in order to avoid detection. Larger direct fire weapons were dug in on reverse slopes with alternate positions and normally at barrel level.[3]

- Desert type terrain makes the engineer requirement for digging greater than other types of terrain.[4]

- Excavation in sandy areas by hand or equipment is difficult because of the constant backsliding of the sand into the on-going excavation.

- Sand excavation is best done by a dozer or bucket type excavator - entrenchers in such soil conditions are ineffective.[5]

- In any protective structure placed in the sand, seepage is copious and any openings (windows, doors, firing slots, ventilation pipes) must be protected against sand leakage.[6]

• Because of a lack of natural construction materials, logistic requirements for fortification were great in WWII and the '67 and '73 wars. A deliberate decision had to be made to fortify with cognizance of the tremendous drain on transport if such a decision were made.

• Egyptian engineer officers interviewed commented on the appropriateness in size, design and power of Soviet engineer excavation equipment in various types of desert terrain for field fortification construction.

• Modular field fortifications are used by both Egyptian and Israeli forces. These modules have been manufactured in quantity; are prestocked in unit sized sets; are the units responsibility for transport forward if needed. They are effective only when dug in and covered by existing soil or other means of layering - sandbags, rocks.

Fig. V-1. Prefab structural shelter. Such shelter would be dug in - covered with canvas or burlap. Egyptian.

Fig. V-2. Prefab MODULAR shelter, surrounded by gabions for protection. Israeli.

• Gabions, prefabricated wire baskets approximately 1 m^3, are filled with local rocks or rubble and used as protective walls for bunkers, shelters, and vehicle emplacement. They are also used as overhead cover when supported properly. Such baskets are prestocked for ready use.

Fig. V-3. Use of Gabions for protective shelter.

• Sandbags are burlap and sand colored.

• Both Egyptian and Israeli army emplacement doctrine calls for the unit to dig itself in - with engineer assistance when available. The tactical commander determines priority of engineer effort.

• Rocky and highland deserts normally are too hard for hasty field fortification digging. To counter this problem, emplacements are made from piling existing rocks into fortifications. Gabions and sandbags are used. Existing depressions and relief are also used in conjunction with dispersion. Sandbags, if used in such areas, normally required extensive logistical effort to bring in sand from distant locations.

• The '67 and '73 wars saw deliberate field fortifications using railroad rails and ties, reinforced concrete members from dismantled/ destroyed buildings, precast/prefab concrete slabs and blocks as structural members. Sandbags and gabions were used as mentioned earlier. Extra long "U" pickets were needed for anchorage of sheeting for sand containment. Burlap, tar paper, sheet roofing, fiberglass sheeting was used to prevent sand seekage into protective positions.

Fig. V-4. Photo showing Israeli position -Sinai-with overhead cover of railroad rails, gabions and effect of sand seepage.

• Experience from warfare in WWII, '67 and '73 wars in desert and mountainous areas re-emphasized need for continuous improvement of protective positions.

• Mines and wire were used extensively in a 360° coverage of protective positions.

• Egyptian armored vehicle crews are expected to dig in their track to defilade before retiring for the night when at the front or in second echelon. Estimated digging time for a tank was 3-5 hours with three men digging.

Countersurveillance Measures.

• The use of dust for concealment and deception was used by the German army in North Africa on numerous occasions. Both the sandstorm, Khamsin, and artificially created dust clouds were used to conceal movement. Rommel frequently utilized his trains or specially equipped vehicles (trucks with airplane engines and propellers on the rear) to create dust clouds to mislead the enemy.[7]

• To preclude observation, direct or aerial, the Germans used depressions in the terrain, shifting shadows and camouflage nets.[8]

• German water and POL vehicles were often configured with different shapes by netting, burlap and wood structures to deceive real purpose of vehicle.[9]

• Tracks of vehicles presented the German army with both the opportunity for deception and the problem of detection by the enemy. Rigid discipline in bivouac and front areas was required to prevent track detection.

• Anchoring of camouflage nets presents a problem in either sandy or hardrock deserts. The problem is holding capacity in sand or penetration ability in rocky areas of the pegs.

• Soviet camoufalge doctrine for desert areas is well developed.

.. Two color disruptive pattern painting of equipment - 70 percent sand and 30 percent in grey/brown is used for sandy and desert areas.[11]

.. Numerous decoy and dummy camouflaged positions are used to detract attention from manned emplacements. Camouflage screenings are organic kits to units and consist of materials for construction of lateral, flat top and vertical screens. Doctrine calls for attention to avoid being repetitious in camouflage techniques as such uniformity eases detection and identification.[12]

• Soviet doctrine on countersurveillance measures requires meticulous terrain study and reconnaissance in advance, particularly for desert operations. Unit leaders estimate possible location of enemy surveillance outposts and devices and their impact on countersurveillance measures to be taken. Repetition in such exercises is continuous. Practice, practice, practice appears to a Soviet training technique, at least, in countersurveillance measures.[13]

• A 15 percent commitment of manpower and equipment from the engineer organization was dedicated to the camouflage mission for defensive positions in WWII by the Soviets. Their claims indicate this effort was worthwhile.[14]

• In addition to netting, tranpaulins are used by the Soviets in camouflage. These are normally covered with a solution of indigenous colors of the area. Emphasis calls for a creative, non-stereotyped approach to desert camouflage.[15]

• Soviet attention on camouflage of combat equipment in the desert recognizes the great difficulty encountered in digging in, securing local material for natural concealment, locating suitable terrain masking positions and simulating local desert area colors in netting and washes for vehicle sides. Strict discipline of track control by vehicles is carried on the premise that vehicle tracks are another easily identified indicator of positions.[16]

- The Egyptian Army utilizes camouflage fatigues that are reversible in camouflage tones, adding versatility in use.

- Soviet use of smoke occupies an important place in their camouflage doctrine. Their WWII experience indicates successful use of smoke screens at any time of year for open sectors. Their experience was most effective in large open areas with wind speeds of 2-4 mps.[17]

The Survivability System. The elements of the current survivability system are not adequate in the areas of equipping, training and employing for desert type terrain of the greater Middle East. In most aspects the survivability mission has been the least resourced and most neglected element of the entire engineer system. For example, US camouflage training, equipage and doctrine - even for a NATO scenario - is neglected in planning, training and practicing phases when compared to Soviet, Egyptian and Israeli emphasis.

US Army MERADCOM analysis of mission capability analysis has determined that:

- More time, manpower and logistic support for construction of field fortifications is required than is normally available on the modern battlefield.

- data on ballistic and NBC protection provided by field fortifications is not adequately integrated with construction requirements to permit operational users to determine how and when field fortifications should be used.[18]

- an inability exists to counter or deceive acoustic, laser, thermal IR, radar MI, and radar sensors.

- an inability to adequately employ tactical decoy and deception maneuvers with acceptable operational/logistics burdens.[19]

Protective Positions. Our analysis of protective position mission task capability has led to the following items for consideration:

- Employment of protective positions as part of terrain reinforcement remains a fundamental doctrinal cornerstone even in the terrain spectrum of the desert.

• The severity of this terrain spectrum offers the commander a classical tactical trade off.

.. A decision must be made between time to construct protective positions, effort required and the potential of dispersion in lieu of protective positions.

• A lack of natural materials or readily available manmade materials hampers protective construction planning and execution - hasty or deliberate.

• Prefabrication and prestockage of modular shelters and fortification materials offer time and construction effort relief but an increased logistical transport load requirement.

• Commanders should be aware of increased engineer requirements in all tasks of the survivability mission in a desert area.

.. Most likely a shortage of engineer effort will exist. Units must be prepared to accept the increased burden of survivability tasks and plan/train for it.

.. Commanders must site and prioritize - the engineer must aggressively advise and assist - all survivability measures.

• Protective construction efforts - hasty or deliberate - afford the enemy ease of position recognition and location. Spoil and construction effort must conscientiously be concealed in progress and at completion. Long distant visibility and barrenness of terrain in a desert area makes such concealment a considerable problem.

Countersurveillance Measures. The desert presents a set of unique problems for countersurveillance tasks with its lack of natural concealment, long distance visibility and blandness of colors. The US Army has not had to face a surveillance threat of any significance since WWII. Surveillance capabilities have increased many times since WWII in sophistication. Surveillance systems now include visual, photographic, acoustic, laser, IR and radar (MTI, millimeter wave and centimeter wave). Countersurveillance efforts must counter each of these by signature suppression, tactical deception and chemical coatings (paints and other chemical layerings). On the modern battlefield if a timely image (visual, IR, laser, acoustic or radar) is presented to a threat weapon, the target will be hit.[20] It is the engineer's role to advise and assist the commander in countersurveillance measures. A sequence of countersurveillance analysis could be:

- Identification of threat capability and employment.
- Analysis of area of operations strengths and weaknesses for countersurveillance measures.
- Preparation of SOP to
  - .. counter threat routine surveillance activities.
  - .. insure correct procedures/techniques are followed to blend with area, avoid visual detection methods.
  - .. insure continuous awareness.
- Continuous detection analysis of our efforts from threat perspective.

Camouflage. Afrika Korps experience in camouflage found that it was very difficult in the desert and in many cases, impossible.[21] The desert environment complicates camouflage with dust signatures from moving vehicles, a lack of vegetation, a variety and contrast of bland colors - brown shades to greys, opportunities for glare and reflective sparkle from equipment, consistency of barrenness of terrain, unwanted shadow thrown from parked equipment, long distance sight capability and ease of track/wheel pattern detection.

Deception. WWII and the '67 and '73 wars saw deception used with varying degrees of success from strategic to tactical levels. The US Army currently has no tactical decoy and deception material in the field and little, if any, doctrine developed for it.[22] Even with the increased sophistication of surveillance techniques of the existing threat, deception should remain a prime element in planning and training for countersurveillance measures. Visual deception techniques can now be supplemented by signature deception techniques from coatings, paints, reflectors and shields. Dust should not be discounted for immediate battlefield deception in the desert. Decoy employment is still valid and needs to be aggressively developed. Time effectiveness and positioning of decoy utilization has been significantly compressed due to improved technology. The question to be weighed in decoy utilization is effort versus time-effectiveness of decoys.

Smoke. Employment of smoke in desert terrain requires the same level of planning, training, and timing as for continental operations. Climatological variances may cause smoke employment problems in the desert. More smoke planning and training needs to be done by the US Army. For desert operations, planners and users should understand the impact of such terrain upon type of smoke and delivery means selected. Today, there is no proficiency in tactical units in either aspect.

Training in Survivability. Training measures in survivability confronts the trainer with the problem that most of the training in th[illegible]ital mission is passive unless integrated with [illegible]her aspects of training. [illegible] must be. Construction of protective positions, camouflage fabrication and smoke employment are normally constrained by time, lack of equipment and materials and environmental considerations. Yet, proficiency in this aspect decreases battlefield lethality and detectability and increase the tactical advantage of the employer of these means. The Army simply does not train enough on this subject, nor is the engineer expert enough to provide the necessary advice to the supported commander.

CONSIDERATIONS AND RECOMMENDATIONS

- The Theater of Operations - Construction in the Desert - Handbook of Lessons Learned In The Middle East compiled by the Assistant Chief of Engineers Office is an excellent reference document for the engineer planner.

- A need exists for design and issue of a protective positions data card or handbook immediately. Such a card or handbook could provide current state-of-the-art capability and techniques for current items of equipment, terrain types and threat considerations.

  .. Data included could be digging time per soil/vehicle/excavator types, schematics for various items of equipment, and ballistic/NBC considerations.

  .. Digging dimensions could be both linear (ft, m) and equipment (length of blade for width, depth of blade for height).

- Utilization of existing modular shelter and prefab structural components (foreign or domestic) should be done now rather than await years of testing and type classifying.

• Gabion use for field fortification construction offers a historically viable and combat tested technique for rapid and effective protection. These should be procurred for use now and trained on by engineers and maneuver arms.

• A quick fix "how-to" handbook on camouflage considerations in desert areas needs to be published <u>now</u> until doctrinal development catches up.

• Acquisition and distribution of individual foxhole covers need to be done <u>now</u> in sufficient quantities to satisfy minimum contingency planning requirements.

• An urgent need for combat equipment excavators exists now. Action should be taken to procure and issue to combat units existing combat excavators, such as the German UNIMOG and other similar civilian items. Expedited development of more powerful and versitile excavators and entrenchers needs to occur.

• Explosive excavators for individual foxhole and for fighting vehicle emplacements are needed <u>now</u> in the force. Existing American and foreign types satisfy interim requirements and should be adopted now for issue.

• Procurement of additional squad level drilling equipment for explosive excavation - such as Swedish Cobra drill - is needed for use today.

• Adoption and issue of new binary mix explosive will greatly assist explosive excavation requirements.

• Spray (pump or aerosal) camouflage paint or coating bits should be developed for various tones and patterns for corresponding desert areas of the greater Middle East. Such covering should chemically include anti-surveillance characteristics for various type sensors (IR, radar, lasar).

- Decoy sand deception capability should be included as part of development package of equipment. Items now in development process should have such added if not already included.

- Not enough smoke generation equipment exists in the Army inventory today. It should be increased in all aspects - individual vehicle capability, smoke generation equipment, and smoke generation units.

- Immediate attention needs to be given to increasing awareness of surveillance capability of threat and countersurveillance techniques currently available. Widest distribution is needed <u>now</u> for trainers and planners. Information could be desert areas specific and in the form of video, hand outs and training kits.

CHAPTER V

FOOTNOTES

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6. Chaim Cohen, LTC, "Military Engineering in the Sinai Desert," The Military Engineer, November-December, 1973, p. 381.

7. Toppe, Ibid., pp. 30; 56-58.

8. Ibid., pp. 80-81.

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10. Fritz Bayerlain, LTG, German Experiences in Desert Warfare - Supplement, p. 5.

11. V. Levin and V. Kolchevsky, Colonels, "Engineer Camouflage," Soviet Military Review, August, 1975, p. 34.

12. Ibid., pp. 34-35.

13. Ibid.

14. N. Yelshin, LTC, "Camouflage in the Desert," Soviet Military Review, August, 1975, pp. 18-19.

15. Ibid.

16. Ibid.

17. Ibid.

18. Ibid., p. V-10.

19. Ibid., p. V1-6.

20. Ibid., p. V1-1.

21. Toppe, Ibid., p. 80.

22. Ibid., p. V1-7.

CHAPTER VI

GENERAL ENGINEERING

General. The introduction of a contingency force into an area like the greater Middle East will find the commander and his engineer confronted with a multifaceted prism of engineer force employment considerations. The normal generic relationship of mobility, countermobility and survivability missions has already been discussed with respect to the difference of employment considerations that must be taken into account for the introduction of a contingency force into an arid area like the greater Middle East. This difference of employment techniques will be even greater for the engineer planner when he considers accomplishment of the general engineering mission. Some of the areas requiring non-stereotype planning will be : command and control relationship of engineers for general engineering, engineer workline location, base development versus temporary construction, permanency of protective construction, airhead or port repair/rehabilitation and tactical versus repair of installed bridging. The accomplishment of the general engineering mission will be dependent upon the commander's determination of what functions must be accomplished in support of the force, what the size of his engineer element is and their equipage and the duration of the contingency operation. Needless to say, the engineer must be in on the overall planning from the beginning for execution of the general engineering mission and the relative time-effort-need tradeoffs that must be made for the various elements of mission accomplishment.

The System. The general engineering mission as defined by FM 5-100 encompasses those engineer tasks which do not directly contribute to the mobility, countermobility and survivability of the committed maneuver forces.[1] Current doctrine constrains the focus of such general engineering support to within the division area. This geographical us is driven by conceptual employment of the force in a continental/m theater that would have the expected rear areas such as corps, COMMZ and theater. Support for general engineer mission accomplishment is provided by corps engineer units assigned to support the division.

Expected general engineer tasks in such a continental theater for offensive and defensive operations are:

- Main Supply Route: Repair, maintenance and improvement
- Bridging: Replacement of assault or destroyed bridges with tactical bridgery; repair in lieu of tactical bridging
- Minefield, obstacle, barrier clearing
- Refuel/rearm forward area development
- Water detection, drilling and construction support
- ⁻ :rain studies
- Protection construction
- War damaged facilities repair and reconstruction: airfields, ports, utilities - other than base development requirements

Our analysis and research indicates that additional engineer tasks might be required in a contingency scenario for a deployed force in an area like the greater Middle East. An area that besides its aridity and terrain spectrum offers a wide range of infrastructure maturity and sophistication, available construction material sources (or lack there of) and water supply problems. Normal doctrine for command and control, engineer management areas, area facility development and management and engineer to force ratios may not be applicable.

LESSONS LEARNED

These lessons learned in General Engineering were gathered from historical research, current literature, observations and interviews from travel. The subject of general engineering is quite broad and diversified. These lessons cover those aspects discovered during the course of our study. Additional research could, no doubt, produce additional items on subject areas not found by the authors in their effort.

- The Corps of Engineers Handbook Theater of Operations - Construction in the Desert is an excellent source of lessons learned, problems identification and possible solutions for the commander and engineer planner. Subjects covered are base protection, water supply, vertical and horizontal construction, port construction, electrical power and factors affecting the engineer work force. Rather than reiterate its valuable information here, the numerous considerations provided in the handbook should be used as a guide in force planning and employment.

MSR Maintenance

- The restriction of cross-country mobility in the desert because of terrain obstacles - dune sands, salt flats, mountain roads - place an extra burden on existing roads. Road maintenance efforts will increase considerably.[2]

- In the sandy type desert, shifting dunes and sand storms cause extra road maintenance effort for needed sand clearance from roads.[3]

- German doctrine - because of road network disparity - emphasized wide dispersal and camouflage of supplies in forward storage areas.[4]

• Supply routes in the desert areas are unusually vulnerable for demolition. Repair effort should be organized on an area basis of responsibility, to be mobile and flexible.

• Road construction and maintenance units are better pooled above division level for MSR support rather than assigned to a division.[5]

• For road maintenance, combat armored bulldozers are not as effective as the normal bulldozer.[6]

• Israeli defense forces normally constructed two avenues of travel to a specified destination concurrently - one for highly mobile traffic and the other for smaller vehicles.[7]

• Road repair experience by the Israeli engineers found more effort would be required in sandy areas because of poor strength of the sand foundation.[8]

• Road maintenance responsibility in combat areas was assigned on a platoon basis ranging from 3 to 25 miles - dependent on the terrain difficulty - by the Israeli forces.[9]

<u>Terrain Analysis</u>

• Operations in desert areas dictate a need for updated and detailed maps.[10]

• An adequate terrain analysis capability with fast dissemination of such to the involved commanders is vital in a desert campaign.[11]

• Terrain reconnaissance and study cannot be carried out too carefully.[12]

• Aerial photos, delivered in a timely matter, are invaluable for planning and navigation.[13]

Water

• After the foundation of the Afrika Korps, a separate water supply organization was organized that covered locating, drilling, pumping, distilling, creating and transporting functions.[14]

• Keeping water cool was a problem for the Afrika Korps that remained unsolved.[15]

• Water was not allowed for vehicle cleaning or washing.[16]

• In North Africa, the chief problem was not water supply but fuel supply and distribution forward.[17]

• Specific geology teams for geological reconnaissance for water were organized. Such small units are a necessity in arid area warfare. Adequate geological research solved a great deal of potential water problems for the German Army. If possible such research should be carried out well before the campaign.[18]

• Equipment for water supply requires hard, fast, strong drilling machines.[19]

• Water pipelines with rapid construction capability saves transport and fuel requirements.[20]

• Organization of water supply units in North Africa for the German Army follows:[21]

..Corps Level - 1 heavy water supply construction company (well drilling)

1 water distillation company (six mobile plants)

2 water filter companies

3 water supply trans. companies

1 water supply point operating company

1 geological detachment

.. Division level - 1 light water supply company

1 water filter company

.. Water transport and supplies below division level was carried out by normal supply transportation service. The greater part of their water was transported in twenty liter cans, as they had few tank trucks or trailers.

• As an example of water availability to the German Army in North Africa, the chart below illustrates terrain types and water sources. (See chart next page)[22]

• The high mineral content of some water sources in North Africa provided both a safety and equipment problem.[23]

• British Army water supply organization was similar to German organization with a vertical organization for command and control.

• Soviet doctrine stresses seizure of water supply sources as critical in desert operations.[24]

• Warfare in the desert and mountains requires a greater effort in engineer reconnaissance according to Soviet doctrine.[25]

• A technique of water distribution by the US Army in the North African campaign was the operation of "wet" and "dry" distribution points. "Wet" points were at or near the water supply source. "Dry" points were set up where the distances from using troops were too great - these were tanker operated.[26]

Airfield Repair

- Airfield damage repair by the Egyptian engineers found that

  . aggregate repair of craters with debris used for crater bottoms was effective.

  .. unexploded bombs provided the greatest difficulty confronting repair teams.

  .. the majority of repairs were conducted at night.

  .. as a result of experience from the '67 war, airfield runway redundency is now included in all airfield.

  .. stockpiling of repair materials assists greatly in repair expediency.

WATER SUPPLIES IN THE DESERTS OF LIBYA AND EGYPT

Type	Nature	Sites	Quality	Quantities	How obtained
1	Rainwater	Chiefly in the coastal region	Good	Variable	The rain water is caught and stored in cisterns
2	Dew water	as above	Good	Small	Gravel pits
3	Rain lakes	Desert proper and coastal region	Good	Sometimes large supplies	By running
4	Ground moisture	In wadis in the desert proper	Poor to fair	Very small quantities	Holes are dug as required after sunset
5	Near surface subsoil water level	In wadis, rubble hills, dunes	Variable	Small in the desert proper, ample near the coast	Wells and trenches
6	Deep subsoil water level	Tripolitania and south of the 29th parallel; oases areas	Usually good, frequently warm and with a sulphur content	Ample	Deep wells, frequently artesian
7	Springs	Cyrenaica, Hefusa Fountain	Good	Ample	Development of the springs
		Harmarica, western desert	Fair	Very small	Development of the springs

Table VI-1

General Engineering Capability. This assessment of current general Engineering mission capability will address those tasks mentioned initially in this chapter. It must be remembered that in a theater such as the greater Middle East there may be more tasks involved in the general engineering mission than already discussed. Such extra or potential tasks will be discussed in the section on employment considerations.

In general, the capability for task accomplishment in general engineering is not adequate from the equipping aspect, the training aspect and the planning aspect. Much thought and action needs to be accomplished raise our level of proficiency and competency in this area.

MSR Maintenance. This task involves mainly horizontal construction efforts in expedient and semi-permanent repair techniques. The goal here is to keep the traffic rolling over potentially long and unimproved MSR's. A MERACOM assessment of such current capability determined that

> Specialized military construction equipment does not exist and available commercial technology cannot execute earthmoving and construction operations at the performance rate required for military operations over the full range of battlefield environments.[27]

Although the M-9 ACE and CEV provide mobility equivalence for combat tasks, the more sophisticated tasks of MSR maintenance cannot be satisfied. Current size of commercial equipment makes it in most cases airlift prohibitive and slow in mobility. Pavement repair and rehabilitation capabilities within the Engineer system are low in density, old in year model, and slow in operational ability.

Training of equipment operators and teams is normally not done in a tactical scenario due to time, training area constraints, construction restrictions and availability of materials. Little planning attention is focused on this task because it is either assumed away in scenarios, not thought of or ignored.

Bridging. Follow-on tactical bridging for replacement of assault bridging or destroyed bridges normally is of a temporary nature. Doctrine delineates types of tactical bridging as dry gap or wet gap. Current available tactical bridging consists of these type sets:

Dry - Bailey
Medium Girder Bridge

Wet - Class 60 Float
M4T6 Float
Aluminum Float (Ribbon)

Gaps likely to be encountered are the dry gaps found in the arid mountainous deserts of the greater Middle East; little if any wet gaps are likely to be encountered with the exception of the few major rivers and the Suez canal. These dry gaps tax the capability of existing sets because of potential length of gap, depth of gap for pier/trestle consideration, and difficulty of reaching gap site. These sets are heavy (by design necessity), bulky and large in lift requirements. MERADCOM has identified these deficiencies in capabilities of current tactical bridging as

- Excessive time and manpower required to deploy, emplace and recover.
- Existing systems are unreliable, not available, difficult to maintain and not durable.
- Problems exist in adequacy of approach and exit ways.

Training on tactical bridging, particularly dry gap, is not frequent enough or adequate. Training of leaders to plan and design bridging requirements has decreased. Because of the NATO focus of the Army, tactical bridging expertise has been allowed to migrate to host nation territorial units and labor service units. The repair of damaged fixed bridges as a tactical expedient has also been degraded in equipping, training and planning aspects.

Minefield Clearing. Although this subject was addressed in the mobility chapter, the inadequacy exists in a large scope when one surveys the magnitude of WWII minefields employed. Current threat employment capability should increase the WWII magnitude even more. Current clearance procedures are inadequate and inefficient in effort and time.

Water Detection, Drilling and Construction Support. The mission of water supply has been divided between Engineer and Quartermaster on the battlefield. Doctrine for such is still in the development stage by both Engineer and Quartermaster schools. This task cannot be accomplished with current equipment capability. Equipment on hand does not possess technology for rapid, accurate detection; fast, power drilling; or quick installation of wellheads or pump facilities. The ability to operate a water supply system in an arid environment has been neglected as the focus of such effort in the past anticipated conflict in a temperate environment where water supply would not be a major problem. MERADCOM's analysis of current water supply (detection to consumption) capability indicates that:[29]

- inadequate capability to detect and produce water supplies in tactical areas.

- inadequate water treatment capability.
- inadequate cooling capability.

Training in all aspects of this task does not receive the proper amount of attention or allocation of effort. Planning is now beginning to receive a major command and staff effort.

Terrain Studies. Our survey of existing terrain study capability and training in troop units found this general engineering task to be in a state of inadequacy similar to the other tasks. While collection equipment capability is clearly able to provide remote data availability to satisfactory detail, the requisite resources in manpower, training or units has not been allocated for subsequent terrain analysis.

Protection Construction. This task lacks similarly in equipage for construction and in prefabricated or modular protective devices/positions as does the suvivability missions capability. While effort expended on this task may be of a greater magnitude and for a longer permanency of construction, inadequate resourcing exists in the current force for task accomplishment even in a continental scenario. Training also receives slight attention in this matter.

War Damage Facilities Repair and Reconstruction. While this task requires no special dedication of equipment or identification of subjects on the training plan, attention paid to this has been scanty over the last decade or more. While normally not a consideration of the engineer system due to the doctrinal focus of the system in front of the division rear boundary, the employment of a deployed force in a contingency operation into a developing area as the greater Middle East causes potential linear and lateral boundary shifts of the normal areas of engineer management. Airfields and ports - normally of no concern to a contingency force engineer - could become of prime importance in focus of engineer effort if they are singular in quantity and damaged. Both airfield damage repair techniques, rapid or semi-permanent, and port construction techniques are currently inadequate due to lack of potential threat since WWII, non-existant adequate repair techniques, little if any training and almost no planning consideration given in doctrinal instruction or actual planning.

General engineering task identification, resolution and prioritization will most likely occur upon deployment of a force into a contingency area. General capability for such planning as observed by this study is inadequate. Consideration of this tasks prioritization and accomplishment needs to be analyzed and resolved now.

Employment Considerations. The priority of engineer effort in a greater Middle East contingency operation will undoubtably go to the missions of mobility and countermobility. However, in such an environment, the commander and his engineer may face the requirements to operate in an unsophisticated and immature are with little or developing infrastructure. What transporation, logistical or other infrastructure elements that do exist may be war damaged and in need of repair. Such repair or rehabilitation may be needed for force expansion and sustainment. Host nation capability or desire to respond to such need may not be adequate or unavailable. Road systems can vary in capacity and adequacy. A sampling of existing road data runs the gamut from new multilane concrete surfaces for sustained heavy traffic to gravel, metalled single lane trails. The most common road surface appears to be a bituminous roadway of 10-16 feet wide designed for light traffic with little base course. MSR's distances from airheads or ports to forward operating areas may be hundreds of miles. Likewise, port capacity, quay unloading capability, egress from port areas, air-landing facilities, parking aprons and utilities in such areas may become for the deployed force a chokepoint in logistics and reinforcement if their state of repair or damage becomes crucial. Such criticality of these facilities will cause the force engineer to consider other aspects of his mission in an area management focus behind the division boundry. Such a contingency environment will most likely invalidate normal engineer area management doctrine, e.g., engineer workline or COMMZ functions. The deployed force will need to assess its priority of engineer effort - in some cases, general engineering tasks may necessitate a higher than normal priority in comparison to mobility, countermobility and survivability.

The length of deployment into a contingency area, the maturity of the area infrastructure, the potency of the threat - conventional and unconventional - and the mission of the force, will dictate the need for consideration of a sustainment capability. Such a capability will most likely include requirements for normal echelons above corps engineer functions. As in the survivability mission, a time, effort, need tradeoff exists for the engineer functions at EAC in such an environment. These EAC functions: construction, war damage repair, real property management, utility operation (to include water supply), topographic support and some combat engineer functions will need to be considered in the planning stage of such contingency operations. Employment of engineer doctrine may have to be revised in the areas of command and control, engineer area management, sizing, equipping and manning of engineer elements. The sequence of deployment and prioritization of effort will require reassessment. General engineering tasks normal for a division's support may become or encompass certain EAC functions in certain scenarios.

CONSIDERATIONS AND RECOMMENDATIONS

- Mission analysis needs to be completed early in contingency planning for determining structure of the engineer force based on potential General Engineer missions.
- Doctrine needs to be examined on engineer employment and accomplishment of General Engineering missions versus EAC functions.
- An employment consideration checklist needs to be developed for such time-force structure-effort tradeoff that would confront the commander of a contingency force when he considers mobility, countermobility, survivability and general engineering priorities.
- Increased priority with concomitant resources needs to be given to terrain analysis units for such contingency planning.
- It is imperative that a desert and arid mountainous terrain EEI be developed now for planning and training purposes. Such standardization of EEI for desert operations would not preclude additional items to be added as required.
- Development of a high performance earth mover system that is multi-use, highly mobile and airliftable needs to be pursued.

- Tactical bridging development needs to be accelerated that satisfies area unique requirements other than a NATO scenario.

- Prepositioning of horizontal construction machinery could reduce lift requirements.

- Prepositioning of current dry gap tactical bridging with accompanying trestle and pier sets could reduce lift and time sensitive requirements.

- Dry gap bridge training needs to be increased with focus on type of situations likely encountered in greater Middle East.

- Rehabilitation and prepositioning of war reserve line of communication bridge sets could expedite rapid war damage repair requirements.

- Protection construction should be increased in training of units both in survivability and general engineering missions.

- Doctrinal review should examine constitution of geology teams trained for water and natural engineering materials detection. The need for qualified teams is urgent.

- As in survivability mission planning, the lack of available construction materials should be taken into account for the general engineer mission.

- Requirement exists for rapid well drilling equipment that is mobile, powerful and quick. Off-the-shelf procurement should be considered if civilian technology has available items.

- Training for water detection, drilling and wellhead construction needs to be increased now.

- Additional data base for potential water source location in specific rather than general areas needs to be done for the greater Middle East.

- Acceleration of potential water sources - air and rain - research needs to occur.

- Compilation of a water source handbook similar to WWII British and German documents should be compiled now.

- Water discipline policy for units and training of water conservation awareness needs to be established now.

- Water pumping equipment needs to be procurred now in sufficient quantities from civilian sources.

- Until a rapid airfield surface repair becomes technologically feasible consideration should be given to:

  .. prepositioning airfield repair kits for guide introduction into the theater.

  .. locating aggregate sources for potential aggregate repairs of craters.

  .. increasing training of potential deploying engineer units in RRR techniques.

  .. additional priority in resolution of the unexploded bomb problem is needed.

- Prepositioning of port construction materials for repair and rehabilitation.

- Requesting from potential host nations - an engineer survey of available sources of commercial equipment and repair parts, construction material sources, construction as - builts plans of potential facilities for contingency force use.

● Increased road maintenance requirements due to lengthy MSRs might require additional motorized graders to be included in the deployment force. With such long distances and types of graveled road surfaces, the grader will become a vital item of engineer equipment in the general engineering mission.

CHAPTER VI

FOOTNOTES

1. US Army FM 5-100, Engineer Combat Operations, pp. 4-26.

2. Alfred Toppe, MG, Desert Warfare - German Experiences in WW II, p. 20.

3. Ibid.

4. Ibid., p. 31.

5. Fritz Bayerlein, LTG, German Experiences in Desert Warfare - Supplement, p. 4.

6. Chaim Cohen, LTC, "Military Engineering in the Sinai Desert," The Military Engineer, November - December, 1973, p. 380.

7. Ibid.

8. Ibid.

9. Ibid.

10. Toppe, p. 1.

11. Ibid., p. 3.

12. Ibid., p. 42.

13. Ibid., p. 81.

14. Ibid., p. 6.

15. Ibid., pp. 71-72.

16. Ibid.

17. Ibid.

18. Ibid., pp. 72-75.

19. Ibid.

20. Ibid, p. 76.

21. Bayerlein, pp.36-42.

22. Ibid., p. 25.

23. Ibid., p. 43.

24. Graham H. Turbiville, "Soviet Desert Operations," Military Review, January, 1974, p. 42.

25. Z. Shutov, Col., "In Desert and Mountains," Soviet Military Review, p. 42.

26. Donald B. Adams, "Water for the North African Campaign," The Military Engineer, April 1946, p. 159.

27. US Army MERADCOM, Fy 80, R & D Plan, p. IV-3.

28. Ibid, p. II-6.

29. Ibid., p. XII-15.

CHAPTER VII

Force Structure Considerations

The goal of this concept paper has been to examine the Engineer System--mobility, countermobility, survivability and general engineering--as it relates to the employment of a contingency corps into the greater Middle East region of the world, and in so doing, evaluate the current/near term capability of engineers to accomplish assigned missions. This chapter will not attempt to define a specific force structure--that structure is mission dependent and must be tailored to meet specific requirements. Our study only has used the current Contingency Corps 86 model as a general basis for our evaluation of engineer Middle East operations.

The Middle East focus of this paper has enabled us to review the historical lessons learned/relearned from past military operations in the area and weigh their applicability to the US Army today given new technology, current equipment and the developing requirement for contingency operations in that part of the world.

Our research has developed general considerations which need to be addressed early in the contingency planning process. They are:

- Inclusion of engineer expertise in the development of the basic plan.
- Early commander's decision on the role of the engineer.
  - .. Mobility vs. countermobility
  - .. Size of the engineer force
- Inclusion of engineer expertise at all levels in the force structuring process.

As fundamental as it may be to the planning process, the inclusion of engineer expertise in the development of the basic plan cannot be over-emphasized. The sheer magnitude of the potential Middle East operational areas, the effect of the terrain on tactical operations, the general lack of theater level infrastructure to support corps operations, and the restrictions on force size and equipment due to extended air/sea LOC's make it imperative that the engineer analysis of the supportability of the commander's concept not be neglected.

In developing the contingency plan, the commander must be advised early on the various roles the engineer force can fulfill in support of the plan. Our research has led us to the conclusion that the engineer forces committed to a Middle East contingency should be weighted most heavily in support of countermobility operations. If the assumption that contingency operations will be primarily executed in the form of defensive/delay tactics in the early phases of deployment is valid, then the combat multiplier effect of engineer forces committed to a countermobility role cannot be overlooked.

The decision to employ engineers heavily in a countermobility role is key, as it directly impacts the size and type engineer units which are programed as well as the time phased deployment of those units. We have concluded that the support of extensive MSR's in the first 30 days of deployment is not feasible. Support of such MSR's would require extensive prepositioning of engineer equipment packages in the region. Since delay/defensive operations are the anticipated norm initially, the engineer contribution to countermobility operations is a much more important contribution to the success of the overall mission. As such, the number of <u>combat</u> engineer battalions, airborne and airmobile, emerge as the key building blocks of the engineer force, based on the evaluated countermobility effort required.

The commitment of engineers to countermobility operations will find engineer elements operating both independently and as part of larger task organizations. Care must be exercised to insure that the maneuver commanders are provided with the appropriate level of expertise to support the mission requirements. Habitual association of engineer platoons to battalion task forces may not be the norm. Battalion task forces may require engineer company effort to include augmentation by platoons from corps engineer battalions. The engineer command and control structure must be well-defined and tailored to the mission.

Figure VII-1 is a recapitulation of our assessment of the engineer system relative to a Middle East contingency operation. The analysis reflects our conclusion that engineer forces should be weighted to the countermobility role. However, planning must include provisions for support of the general engineering, survivability and echelon above corps (EAC) requirements. Mobility requirements can be traded-off from those assets allocated to countermobility operations as mission requirements dictate. As time in theater increases, the general engineering and EAC requirements will likewise increase. This will necessitate introduction of additional engineer forces, equipment and the utilization of host nation assets.

Specific Considerations

The remainder of this chapter will identify specific considerations for force structure planning which were developed during the course of the study project.

The structuring of Middle East contingency forces should concentrate on the inclusion of corps combat engineer battalions supported by combat support equipment companies (CSE) in lieu of combat heavy engineer battalions.

Figure VII-2 depicts the difference in equipment densities provided by the different units. As the general engineering requirements increase, the equipment packages contained in the combat battalion and CSE companies provide a higher density of equipment. Noteably, the combat battalion also provides

	CONCEPTS/DOCTRINE	ORGANIZATION, PLANNI FORCE STRUCTURE
MOBILITY	• Mobility operations should primarily support offensive operations • Doctrine oriented to breeching and gap-crossing operations needs attention. • Develop mobility oriented arid mountainous/desert EEI.	• Expand reconnaissance capability Platoon .Train to the Mid-East • Expand engineer use of airmobile assets. • Include engineers early in planning. • Provide engineer expertise at all levels • Provide mobility equivalence for engineer force
COUNTERMOBILITY	• FASCAM doctrine needs emphasis. • Review mine warfare doctrine for desert use. . Panel emplacing procedures ..Define marking responsibilities ..Delegate approval authority • Develop countermobility oriented arid mountainous/desert EEI. • Develop guidance for priority/type non-engineer countermobility effort.	• Need guidance on FASCAM composition of artillery/aviation basic loads. • Develop engineer force structure using days of delay criteria per engineer unit committed. • Engineers need ATGM/Air Defense supp • Light Corps must have airborne combat engineer battalion and light equipment company assets at Corps level. • Specific levels of non-engineer effor for countermobility operations must be defined in orders.
SURVIVABILITY	• Need doctrinal guidance on level of effort to be performed by non-engineers. • Smoke doctrine needs attention. • Need increased emphasis on the inclusion of a countersurveillance annex/paragraph in operation orders. • Develop EEI for anti-surveillance planning.	• Priority for engineer survivability effort must be developed early. • Increase. .Surveillance/countersurveillance capability for desert operation ..Decoy capability of standard equi ment. • Insure inclusion of anti-surveillance plans in operations orders • Plan on using survivability technique in NBC environment
GENERAL ENGINEERING (GE) AND ECHELONS ABOVE CORPS (EAC)	• Doctrine needs review for GE vs EAC functions in contingency area. • Develop arid mountainous/desert EEI for GE requirements. • Re-evaluate terrain analysis team sufficiency for Mid-East contingency.	• Need mission analysis early to structure • Develop checklist for time-force-structur effort trade-off. • Terrain analysis units need higher priori • Need high speed well drilling teams ..Pumping equipment ..Detection teams • Consider. ..Geology teams ..Port and beach reconnaissance teams • Conduct engineer surveys with friends/all on infrastructure and construction mate sources. • Develop data base from Corps of Engineer Middle East Districts • Minimal GE effort in first 30 days--concentrate on Air Loc's

FIGURE VII-I

ASSESSMENT OF THE ENGINEER SYSTEM FOR ARID MOUNTA

ANIZATION, PLANNING, FORCE STRUCTURE	TRAINING	MATERIAL/RESOURCE SUPPORT
• Expand reconnaissance capability ..Platoon ..Train to the Mid-East • Expand engineer use of airmobile assets. • Include engineers early in planning. • Provide engineer expertise at all levels. • Provide mobility equivalence for engineer force	• Develop Reconnaissance NCO Course -Mid-East oriented. • Increase desert oriented night training • Need extensive production of mission area literature ..Area Handbooks ..Video Tapes ..Speakers program using Mid-East Construction Experts • Develop airmobile assault breeching battle drills	• Expedite ..POMINS ..Helicopter delivered line charges ..VMRMDS AMIDS ..Image interpreters handbook • Navigational Aids ..Individual ..Vehicle ..Unit • Provide ..Dry gap bridging capability ..M9 capability for light units
Need guidance on FASCAM composition of artillery/aviation basic loads. Develop engineer force structure using days of delay criteria per engineer unit committed. Engineers need ATGM/Air Defense support Light Corps must have airborne combat engineer battalion and light equipment company assets at Corps level. Specific levels of non-engineer effort for countermobility operations must be defined in orders.	• Train to the Middle East. • Develop Middle East Training Site (as part of National Training Center). • Intensify .Battle drills (Engineer) ..Airmobility training ..Reconnaissance training ..Battle drills (Combined Arms) • Develop engineer platoon training in conjunction with Special Forces/Ranger battalion units.	• Expedite ..M180 cratering system .M56/FASCAM ..Binary explosives • Provide ..Ground mobility platforms ..M9 capability for light units.
Priority for engineer survivability effort must be developed early. Increase ..Surveillance/countersurveillance capability for desert operations ..Deploy capability of standard equipment. Insure inclusion of anti-surveillance plans in operations orders. Plan on using survivability techniques in NBC environment	• Develop . Protective position data card .Camouflage handbook or tactical training pamphlets. • Train continually w/camouflage. • Develop threat (Soviet) oriented anti-surveillance training (tasks, conditions, standards) for all potential sources (visual, photo, acoustic, laser, IR). • Increase training in actual protective position construction--incorporate not simulate. • Train on survivability subjects in NBC environment.	• Expedite ..Available cmd/individual structures . Gabions ..Combat excavation equipment (off the shelf) ..Squad drilling equipment ..Binary explosives Spray camouflage .Smoke generating equipment ..Increase issue of camouflage net kits to contingency units • Procure: ..Small equipment excavator (e.g UNIMOG) • Provide M9 (ACE) capability • Develop: .Decoy systems for desert operations for major items of equipment
mission analysis early to structure force. op checklist for time-force-structure-ort trade-off. in analysis units need higher priority. high speed well drilling teams umping equipment etecrion teams der: ology teams ort and beach reconnaissance teams ct engineer surveys with friends/allies infrastructure and construction material rces. lop data base from Corps of Engineer dle East Districts al GE effort in first 30 days--centrate on Air Loc's.	• Intensify. ..Dry gap training Airfield repair training • Develop ..Water source data base Water source handbook • Increase terrain analysis training in CPX's and FTX's	• Preposition· ..CSE companies ..Well drilling equipment ..LOC/Tactical bridging sets ..Additional graders ..Airfield repair kits and materials • Need: ..Multi-use, high performance, airlift/airmobile earth mover (off the shelf) ..TACIPRINT terrain product reproduction system with photo capability ..Location/Survey of available engineer materials ..Navigational aids

FIGURE VII-I

FOR ARID MOUNTAINOUS/DESERT CONTINGENCY OPERATIONS

COMBAT ENGINEER BATTALION + COMBAT SUPPORT EQUIPMENT COMPANY (CSE)

VERSUS

COMBAT HEAVY ENGINEER BATTALION

COMBAT BN + CSE CO		COMBAT HVY BN
12 COMBAT ENGINEER PLTS		6 CONSTRUCTION PLTS
14 DOZERS		11 DOZERS
14 BUCKET LEADERS		6 BUCKET LOADERS
13 GRADERS	VS	9 GRADERS
9 SCRAPERS		12 SCRAPERS
7 CRANES		7 CRANES
26-20 TON DUMPS		20-20-TON DUMPS
59-5 TON DUMPS		3-5 TON DUMPS
1001 PEOPLE (TOE)		853 PEOPLE (TOE)

Figure VII-2. Comparison of Combat Engineer Battalions Augumented by Combat Support Equipment Companies versus Combat Heavy Engineer Battalions. (Comparison developed by 20th Engineer Brigade).

significantly more combat engineer platoons, giving the combat battalion the flexibility to provide countermobility/mobility support. The combat heavy battalion, with construction platoon composition and noncombat engineer MOS's (51H, 62C), cannot efficiently provide needed M-CM support.

There is ample historical evidence to support the requirement for expanded engineer reconnaissance capability at the corps engineer level. Our conclusion is that a reconnaissance platoon, properly trained, and integrated into the all-source intelligence collection effort is necessary. This platoon can provide overall corps level engineer reconnaissance effort and be trained for special tasks such as geological analysis, water source location and trafficability evaluation. Corps terrain detachments could provide the basis for such a platoon. The reconnaissance platoon recommended is in addition to reconnaissance teams currently found in the combat engineer battalions. It is absolutely essential that the reconnaissance personnel be trained in depth for Middle East contingencies. No comprehensive training program such as we suggest is available today to support this recommendation. The US Army Engineer School should investigate the instruction given in the Israeli and Egyptian engineer schools for applicability, as well as British reconnaissance course materials. An Engineer School level course should be developed to support a reconnaissance training program.

The contingency corps organization will be required to provide certain levels of echelon above corps support from the outset. The provision of water to the corps is perhaps the single most important requirement. Consideration should be given to the constitution of composite teams for each phase of the water mission-water reconnaissance/detection, drilling, construction--and mission area training conducted and sustained for such teams. The German and British experience in WWII provides excellent source material in evaluating the need for and creation of such teams. These teams need to be highly trained prior to deployment; lack thereof could be a critical deterrent to mission success.

Additional specialty teams such as port and beach reconnaissance specialists are needed. This requirement could possibly be satisfied by the inclusion of existing naval reconnaissance teams. This item should be analyzed further. Geology teams, trained in water source and construction material location are also important. The recommended reconnaissance platoon should have training in this area, but the need for specific geology trained teams is also apparent from our research.

Serious consideration should be given to the provision of a terrain detachment reproduction system similar to the British TACIPRINT Terrain Product/Reproduction System and fielded to division level, and possibly brigade level. The system is a highly mobile unit (2½ ton truck), which provides multicolor, high speed map sheet printing with graphical overlay capability as well. Photo reproduction capability utilizing high speed black and white or color photo processing is commercially available now, and can be included in the TACIPRINT System. This could be linked also to USAF high resolution photo products, giving near real time updated map/photo material.

Terrain analysis teams, although currently in the force structure, need to be reevaluated in terms of their ability to prepare data bases, collect new data, analyze and produce products which are uniquely oriented to desert operations. Regional data bases must be prepared prior to deployment.

Consideration must be given to the prepositioning of engineer equipment in the Middle East theater. Although this paper concentrates on the countermobility role for engineers, the mobility/general engineering missions can be enhanced substantially by the prepositioning of selected equipment. The comparison cited earlier on deploying CSE companies and combat engineer battalions vice combat heavy engineer battalions logically presents those units for prepositioning consideration. The substantial difference in equipment costs for a combat heavy battalion versus a CSE/combat battalion would weigh heavily in the argument. We conclude that prepositioned CSE companies, in sufficient numbers to support current contingency operations, would provide the optimum <u>early</u> availability of general engineering/EAC equipment requirements. Well drilling equipment detachments should be attached to such companies also for obvious reasons.

Earlier discussion in the general engineering chapter highlighted the need for additional graders in engineer units in support of extensive MSR maintenance operations. As requirements are determined, such graders could also be placed in prepositioned CSE companies.

There is an identified need for prepositioned LOC and fixed bridge repair sets, similar to those found in NATO war reserve, to include piers, trestles and suspension systems. The need for dry gap bridging and repair capability, particularly in eventual MSR repair of interdicted road networks, cannot be overlooked. The LOC sets can be adapted to the situation, can be employed using helicopters instead of cranes if necessary, and can be employed by division or corps combat battalion engineer elements. The weight and cube of this capability makes its prepositioning a necessity.

Navigation aids are a must--not only for engineers, but all elements of the contingency force. Individual compasses as well as vehicular navigational aids <u>must</u> be provided. Commercially available position-locating devices should be evaluated and issued to specific units such as the reconnaissance platoon cited. This area is a significant current shortfall.

The Corps of Engineer District Engineer operations in the Mid-East are a source of data which must be utilized as an important input to Middle East contingency planning. US firms conducting business in the Middle East should likewise be used as potential sources for identifying infrastructure, construction material and equipment resources for contract, and personnel expertise in the area of operations. This area should be the subject of extensive study. As an adjunct, contingency units might contract civilian personnel with experience in desert construction activity to speak to the soldiers and staffs of selected contingency units as a means of imparting some perspective on the difficulties of operating in such environments. A program of this type could cover a wide range of subjects and substantially supplement training programs for desert operations.

Finally, arid mountainous/desert training programs need to be developed with some degree of centralized direction. Many units have programs ongoing, but there is a need for more specific guidance and the availability of training materials. Current FM's are woefully short on describing mountain/desert training requirements. Videotapes covering many of the points covered in this paper, but in considerably more detail, would be an excellent starting point. Environmental considerations, and particularly the integration of engineers into the anticipated type tactical operations, needs training emphasis. Combined arms battle drills, whether mobility (breeching operations) or countermobility (mine/obstacles) are prime candidates for videotape modules. The use of smoke, helicopters, air defense, infantry security, suppressive air and artillery fires and ATGM employment are subjects not well understood by engineer officers, but are key ingredients to battle drill execution.

There is also a need for "stopgap" area orientation literature, perhaps in handbook form, geared to Middle East operations. Tactical Training Pamphlets (TTP's) have been used similarly in the past until written developing doctrine was disseminated. Some items for consideration could include:

- Survivability methods/equipment.
- Navigation.
- Survival techniques.
- Water source detection.
- Use of cratering change systems for landslide/obstacle development.

The training aspects of preparing soldiers for Middle East operations is a formidable task. Soviet desert training includes extensive activity explaining the peculiarities of combat in desert and steppe terrain. This includes the periodic distribution of leaflets explaining techniques, methods and specific situations.[1] We cannot afford to do less!

Of all the obstacles to the
March of an Army, the most
difficult to overcome are
deserts; mountains came next;
and broad rivers, the third
place.

Napoleon

CHAPTER VIII

ADDITIONAL CONSIDERATIONS

In the course of our historical research, review of current literature and travel, it became apparent that a need existed for additional research and publication on operations in arid mountainous and desert regions. The areas of doctrine, equipage and training that cover such type of operations are not adequate for a force commander or planner. This chapter presents additional considerations in those three areas that were gleaned as a result of our research efforts on engineer operations in arid mountainous and desert areas. They are not necessarily "engineer focused," but rather cover items of information or ideas that should prove helpful in the planning or execution stage of training or deployment into the terrain spectrum of the greater Middle East.

Training Considerations

- Minimum training requirements established for Afrika Korps were:[1]

(1) Exercises of all types in marching and combat in open, sandy terrain.

(2) Cover and camouflage in open terrain.

(3) Aiming and firing of all weapons in open terrain and at extremely long ranges.

(4) Recognition and designation of targets without instruments. The aiming and firing exercises were to be carried out by daylight, at night, in the glaring sun, during twilight, facing the sun, with the back to the sun, with the sun shining from one side, by moonlight and with artificial lighting.

(5) Exercises during extreme heat.

(6) Exercises of long duration with no billeting accommodations.

(7) The construction of shelters in sandy terrain.

(8) Practice in night driving and in driving over sandy terrain.

(9) Nightmarching in level terrain.

(10) Orientation by compass, by the stars, and so forth.

(11) Driving by march compass.

(12) Recovery of tanks and other vehicles in sandy terrain.

(13) Laying and removing mines in sandy terrain.

(14) Exercises in mobile warfare.

- Current British doctrine establishes these topics as requirements as a minimum:[2]

TOPICS TO BE COVERED IN DESERT TRAINING

(1) Physical fitness.

(2) Desert environment and living.

(3) Medical.

(4) Acclimatization.

(5) Terrain briefing.

(6) Enemy organization and tactics.

(7) Movement, driving and maintenance.

(8) Navigation.

(9) Survival, escape and evasion.

(10) Camouflage, concealment and protection.

(11) Mine clearance.

(12) Special maintenance techniques.

(13) Weapon training.

(14) Desert tactics.

(15) Communications and security.

(16) Language.

- Acclimatization of troops introduced into a hot, arid area is important. The Afrika Korps experienced its most severe problems with acclimatization initially and not the enemy. Casualties ran as high as 50 percent in some units from combined effects of heat, inadequate acclimatization and dietary problems.[3]

- Training of drivers for desert types of terrain is mandatory.

- Land navigation training - although previously mentioned - is an absolute must for a leader. Soldiers need proficiency in this along with their leaders.

- Light and noise discipline must be practiced and emphasized constantly in the desert and in preparation for desert operations. Soldiers must be shown the remarkably long sight and sound detection capabilities of themselves, and hence the enemy, in the desert.

- Nighttime training is another essential element of a training program. Because of the intense heat, most combat operations in WWII occurred in the early morning or evening.

- Water discipline training for personnel and equipment consumption must be taught and emphasized again and again. Soldiers and leaders must understand body requirements and techniques for minimizing water consumption.

- Mission oriented training needs to be conducted with emphasis on unique problems found in arid mountains and deserts. Such training should be conducted in terrain found in our own Sonora desert or in training areas made available by friendly nations. Level of training should not be below battalion task force size.

• Prepared videotape cassettes (in addition to those mentioned previously) could provide material for the small unit's orientation and training - a focus on such common subjects as terrain, hygiene, navigation, dust problems, driving and recovery operations, heat injuries that are area applicable would be a starting point.

• Camouflage - as already mentioned - needs to be practiced, practiced and practiced.

• Appreciation of the impact of heat on radio transmission must be introduced into desert preparation training.

• Extensive training and review of operations in a chemical environment must be undertaken. Efficiency of soldiers could be reduced over 50% in the desert; the effect of this efficiency reduction on engineer required operations has significant mission impact. Actual testing is a must - we have no current empirical data base. Decontamination procedures for desert operations also needs to be addressed.

Doctrinal Considerations

• Consideration should be given for re-establishment of geographical/ region terrain intelligence teams. Such teams, invited in by the host country, could prepare invaluable terrain dossiers that would make up for the existing deficits of such information now.

• Development of motor march doctrine for desert type terrain that addresses dispersion, all-around defense, reduction of visual, acoustical and thermal signatures as a minimum should be developed.

• Development of fighting position doctrine for new weapons systems in desert environments needs to be addressed with infantry/armor/artillery combat developers. ATGM systems, for one, are hard to conceal, vulnerable (launch signal and time of flight) and can be neutralized by fire or smoke unless provided with overhead protection and thermal imagery sights.

• Use of FASCAM employment and engineer involvement therein needs to be addressed for such operations as protection of near area landing zones, installations and supply points.

• Serious, extensive, conceptual thought must go into developing engineer portion of battle drills for breeching, cratering, gap crossing and other type operations most likely to be encountered when using airmobile tactical operations.

Equipment Considerations

- Air cooled engines work best in arid areas. This conclusion was reached by both German and Egyptian armies from their campaigns.

- Oversized aircraft tires are excellent for sand trafficability for light vehicles.

- Rearrangement of air intakes to a side position with a rear facing intake assists in preventing sand and dust from getting into engines.

- Filter usage is many times higher than normally experienced. Change frequency is much greater.

- Lubrication requirement in desert areas is substantially greater than in temperature climates.

- German experience with batteries in the desert heat had problems holding the normal charge.

- Optical instruments and other similar devices need to be protected from fine sand and dust. Gun covers for barrel and breech mechanism are necessary.

- Individual clothing and equipment needs to be able to contend with the temperature extremes. Goggles and a cotton scarf (or mask) are a necessity. Skin and lip emollients are necessary on each person.

- With an exception of footwear, the Afrika Korps use no leather in any article of apparel; it was replaced everywhere by thick linen.

- Vehicle equipment needs to include rope ladder or metal guides for extracation from getting stuck in the sand.

- British doctrine requires the following items on each vehicle for desert operations:

Vehicle Kit

Vehicles operating in conditions where there is excessive wear and tear must carry:

a. Water and survival rations.

b. Spare POL.

c. Spare tyre (or tyres).

d. Tow chain.

e. Digging tools.

f. Sand mats and channels.

g. Camouflage net.

• Insects - flies, gnats, chiggers, fleas - all cause tremendous problems in hygiene and personal comfort. Other animals and insects - ground borne: scorpions, snakes, lizards - also offer poisonous hazards for individuals. Equipment for prevention and protection from such pests must be available.

• Navigation equipment is essential for individuals and individual vehicles - as a minimum - SILVA type compasses for the soldier and correctable gyro compasses for each vehicle. Not enough emphasis or appreciation is paid to this vital subject.

• Consideration must be given in planning of airmobile operations of the effect of heat on lift capability in a desert and arid mountainous area.

• Mountain areas even in an arid climate often require the need for sand, salt or other necessary traction items for wheeled vehicles due to potential freezing of road surfaces.

• Soldiers must continually be made to appreciate the effect of sand on all resources, but in particular vehicles. German experience indicates that engines in WWII had the following comparative life cycles:

	Europe	(KMS)	Africa
Command Car	60,000		13,000
Tank	7,500		3,500

CHAPTER VIII

FOOTNOTES

1. Alfred Toppe, MG, Desert Warfare - German Experience in WWII, p. 10.

2. Uk, p. Fl.

3. Toppe, *ibid.*, p. 10.

Finis

This study has examined in some detail the multiplicity of problems unique to a mid-east theater of operations. In doing so, our underlying goal has been to present a concept paper which might stimulate the thoughts of combat engineers in the preparation of not only contingency plans in that area of the world, but also in the development of contingency corps models for future force structure development. Through it all, the authors have been struck by not only how little we know of that environment, but how much has already been learned and only requires rediscovery. It is indeed time we started to look more intensively at the arid mountain/desert region as a potential theater of operations.

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APPENDIX I

1. Purpose of trip: To provide additional expertise and information for an AWC student concept paper that addresses utilization and employment of engineers in desert area operations.

2. Method of investigation and research:

a. Historical research and literature search of current and past writings on employment of engineers in desert operations.

b. Evaluation of desert training operations of US Army.

c. Interviews with army officers possessing training and combat experience in desert operations.

d. Site visits with friendly armies for discussion and observations of training, equipping and preparing engineers for desert operations.

e. Egypt and Israel have been identified as potential countries for separate visits.

3. Specific interests for potential Egypt visit:

a. Discussion with engineer officers that have combat experience from 1967 and 1973 wars.

(1) What is best force ratio for engineers to combat arms?

(2) What is employment of engineers in advance, penetration and defense?

(3) What is command relation between engineer and supported unit? in planning phase/in operation phase?

(4) How involved and what is lowest level engineer gets involved in combat operation planning?

(5) What difficulties does engineer encounter in command and control in the desert in support of combat operations?

(6) Are engineers employed in different methods in the different types of desert terrain - sand dunes, rocky terrain, hills?

(7) What are different types of engineer units best suited - light, heavy, construction, bridging, topographic, terrain?

b. Discussion on training techniques for individuals and units - with individual officers and the Egyptian Engineer School:

(1) What training problems do you encounter for training the individual combat engineer?

(2) What training emphasis is placed on desert terrain utilization to officers and noncommissioned officers?

(3) What is done for training combat arms leaders on engineer utilization?

(4) What is and how much training is given to different missions of engineers in areas of mobility, countermobility and survivability?

(5) What is best layout for a desert training facility for engineers?

(6) What and how much training is conducted at night?

c. Discussion on engineer equipment design and utilization in desert operations:

(1) What is need for mobility equivalence with supported combat arms?

(2) What specialized equipment do you use for mobility and countermobility missions? What is it used? How good is it? How could it be improved? What do you need now that you do not have?

(3) What maintenance problems, other than supply of repair parts, does the desert cause for engineer equipment?

(4) What is necessary for individual combat engineer to carry?

(5) What type and where is bridging employed?

d. Site visitations desired:

(1) Training sites for engineer soldiers.

(2) Observation of varied types of desert terrain - dunes, rocky, hilly terrain, escarpments.

(3) Visit to 1967 and 1973 battlefields for terrain appreciation/understanding of engineer employment.

(4) Training sites or locations where engineer equipment is employed.

(5) Visit to fortification sites from earlier war.

(6) Visit to engineer officer school

(7) Discussion with selected officers on their experiences.

Countermobility

- How effective is antitank ditching in a desert area of sand dunes? other areas?

- How do you correct the problem of misplacing/losing minefield reference points/locations due to drifting sand?

- How do you correct the problem of mines being uncovered by drifting sand?

Survivability

From your experience, what type of field fortifications work best in different types of desert terrain? Rapid type and deliberate type? For weapon emplacement, for individual soldier protection and for vehicular/armor emplacement?

- What do you recommend for individual soldier protection in the area of field fortifications?

- What use is made of entrenching machines for field fortification?

- Desert areas have very little natural construction materials available for field fortifications and bombers - what techniques do you have for field fortifications and protective structures?

- What camouflage techniques are best for desert operations - pointing, site, position, deception?

Mobility

- What techniques are used for minefield detection? remote, airborne, accuracy?

- Where is countermine equipment located? only in engineer units, in both combat and engineer units?

- What do you recommend for a combat engineer vehicle in the desert? loading, munitions, mobility?

- Who is in charge of using the mechanical mine devices? Engineers? Armor with attached engineers? Armor?

- What is the doctrine for minefield breaching? What are most effective techniques, mechanical, munitions, personal? What is planned for rate of clearance, km/hr?

- What do you have for mechanical mine removal? flails, ploughs, rollers?

General Engineering

- How much effort must be placed on line-of-communication (road) maintenance during combat operations in the desert? Who does it - Divisional, Corps Engineers or others?

- What experience have you had in repair of bomb damaged airfields? What techniques are best? Problem with foreign object damage and explosive removal. Dust palliative techniques and need. Training time and techniques.

- How do you control dust in field locations? Roads, airfields, cantonments?

- What problems are encountered in land navigation and how do you train for them?

- Do desert conditions cause any special problems in demolitions, e.g., effect of heat upon explosive material?

What are specific problems in field sanitation that engineers would face in the desert? More construction, more excavation?

- What is the requirement for communications equipment for combat engineers in desert operations? for construction/rear area engineers?

Water

- A general discussion on water problems in the desert: supply-unit and individual; location and construction; transport; planning factors; purification and processing techniques and procedures; doctrine and discipline; organization; temperature control.

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